Contributions to the Natural History of Lake Urmi, N.W. Persia, and its Neighbourhood.

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(Map Pl. 21 & Plates 22–30.)

Contents.

General Remarks.

It is now more than three years since Mr. P. L. Sclater showed me a letter from my friend the Rev. F. F. Irving, dated Urmi, Oct. 6, 1895, in which the organism dwelling in the Salt Lake of Urmi, which Lord Curzon of Kedlestone had previously referred to as a jellyfish, is compared to "a tiny shrimp." Further searches in the literature showed that Abich had already recorded the presence of a Crustacean, but that the majority of travellers and writers described Lake Urmi as a "Dead Sea," totally devoid of life on account of its excessive salinity.

I received private information that edible fish were to be caught in the rivers; but I was unable to obtain any further information

concerning the aquatic fauna of the Urmi basin, although its fossil fauna had been frequently described.

The fascination of an apparently entirely unknown zoological region near the waterparting of the hydrographic systems belonging to the Atlantic, Arctic, and Indian Oceans, induced me to devote a summer vacation to visiting the plateau of North-western Persia.

The chief problems which attracted my attention were naturally those which centred around the salt lake and its fauna, and its tributaries and their faunas; but incidentally I was able to collect a few terrestrial animals, which are described in the Reports. The results obtained during a few weeks of summer show, I think, how much still remains to be done by a naturalist-explorer who may be able to work the Urmi district during those months of the year which are most favourable for the purpose of collecting.

The present communication is chiefly concerned with observations and collections made between the middle of July and the middle of September, 1898. Wherever I have profited by the work of others I have endeavoured to make due acknowledgment but, in addition, I should like to record my especial obligations to a more extended circle of helpers. I am indebted to the Royal Society for a grant in aid of my expedition; to the Foreign Office for most useful letters of introduction; to Prince Imam Guli Mirza, at the intercession of the Amir Nizam, for the loan of the 'Nahangk,' a vessel of some 20-tons burden, upon the Lake of Urmi; to Mr. E. Chapman; and to the past and present members of the Archbishop of Canterbury's Mission to the Assyrian Christians at Urmi. Lastly, my sincere thanks are due to my friends and coadjutors, who have unselfishly helped on my own studies at the expense of their own, and who have contributed the most valuable part of the present paper. My readers are indebted to the Council of the Royal Geographical Society for permission to republish my map of the neighbourhood of Urmi, originally contributed to the Journal of that Society.

Before proceeding to the more purely biological characteristics of the region, it may be well to recall to mind its main physiographical features—its "external conditions of existence."

The geographical and, more particularly, the hydrographical relations of Azerbaijan, the N.W. province of Persia, are of interest because the highlands of this province are part of the system in which the most important waterpartings of the Old

World meet. The divides which separate three great systems of rivers—namely, the river-systems of the Indian Ocean from those of the Atlantic, the river-systems of the Atlantic from those of the Arctic, and the river-systems of the Arctic from those of the Indian Ocean—meet in the highlands of Armenia and Kurdistan, between the massif of Asia Minor and the Persian plateau. Notwithstanding the altitude of the region, the meteorological conditions tend towards those of a desert, and produce features characteristic of deserts. On the whole the annual evaporation is so much in excess of the annual precipitation that the lakes do not overflow, and their water is more or less salt. Similarly, in Turkish territory we have Lake Van, in Russian territory the Caspian Sea, and in Persia Lake Urmi.

Climate.—The climate of the Azerbaijan plateau may be fairly classed among the continental, or "excessive" climates as they have been termed by Buffon; but at the same time it is the healthiest in Persia, because the summer heat is more tempered than in the other provinces and there is generally a sufficiency of water for man and beast.

The seasons are extreme, but very variable both as regards duration and time of year. This variability is largely due to the fact that these uplands of N.W. Persia, of 4300 feet altitude and upwards, form part of a tongue of high land which runs from N.W. to S.E., and divides the warm depression of Mesopotamia, in which the palm-tree flourishes, from the deserts of Persia and from the hot South-Caspian provinces of Ghilan and Mazenderan. Thus we find, in close proximity, the snow-mountains of Kurdistan and tropical lands warm enough for the growth of the date-palm. It is a pity that methodical meteorological observations in so interesting a region should be practically non-existent. In default of the more accurate indications of the meteorological conditions, I am compelled to supplement my remarks by such observations on animal and vegetable life as seem to afford information on the climate.

The winter snows may commence towards the end of November (23rd in 1890), or they may not fall until February 1st (1893), There is often fine weather between the first snows and those of January and February. The last snows may fall as late as Lady-day. In cold January weather the minimum thermometer sometimes falls below 0° Fahr. (12° F. is a common temperature), and the snow does not melt in the middle of the day. As a general

rule, snow may be expected to lie on the ground in the plain for three or four months, and on the hills (6000 feet) in streaks until well into July. In the winter of 1895 there is said to have been no sunshine for five weeks.

When spring comes the snow melts, often with surprising rapidity, and a few days' warm sunshine produces a marvellous change in the aspect of the country. Irises of a delicate purple colour, and white and pink crocuses are in flower before the end of March; the plum blossoms by the 1st of April, and sometimes even in March, with snow on the ground. The quince blossomed on April 18th in 1891. At the same time the storks and hoopoes return from their winter pilgrimages; the earliest record of the stork at Urmi seems to be March 14th, in 1898.

Summer commences about St. George's day, on May 6th, and usually lasts unbroken until late in October; popular tradition prolongs it until the second St. George's day in autumn, on the first Monday in November (O.S.). Rarely, as in 1895, a few rain-storms interrupt the continuity of the hot weather.

During the warmest months it is hot even at 6 o'clock in the morning. The glaring, eye-dazing sky is unrelieved by any clouds. The shade temperature rises to 90° F. in the open, and much higher among the sun-baked mud-walls of the villages. The nights are generally cool, and become uncomfortably cold during the latter months of summer, owing to unchecked radiation. The greater number of the fruit-trees are in blossom in the first week of June. The first fruits to ripen are the white and morella cherries and plums, which are followed by peaches and apricots, and in August by an abundance of excellent nectarines, melons, grapes, and also of cucumbers, vegetable-marrows, black and red tomatoes, &c.

No climate would seem better adapted for the growth of the vine. The grapes of the plain of Urmi are magnificent, both in flavour, size, lusciousness, and variety. On the other hand, the severe winters do not permit of the cultivation of the orange and the lemon.

Rainfall.—The rainfall seems to have been recorded during the year 1853–54*, but I have been unable to discover any subsequent series of observations. During that year 547 millimetres of rain seem to have fallen, and the monthly rainfall was

* Supan, in Petermann's 'Mittheilungen,' Ergänzungsheft No. 124, 1898.

as follows :—January 43, February 72, March 103, April 133, May 62, June 11, July 0, August 12, September 16, October 38, November 24, December 33 : total 547 millimetres.

Irrigation and Agriculture.—On the Urmi plateau, wherever there is water there is agriculture. Without artificial irrigation the greater part is a sterile waste of gravel, capable of supporting little but thistles, *Centaurea*, *Carduus*, *Achillea*, *Pyrethrum*, and other plants characteristic of the Persian steppes. In spring, the snow has hardly had time to melt away before this steppe-vegetation covers the plains and hillsides with a green mantle ; but soon the water in the soil commences to give out, and then the brown-burnt stalks and leaves demonstrate the cessation of vegetable growth.

The chief objects of the agricultural engineer are first to convey water, with as little loss from evaporation as possible, from the valleys near their emergence from the hills to the most fertile soil of the plains, and, secondly, to distribute the water over as great an area as possible. The Persian poets praise King Menucheher as the inventor of the system of subterranean canals which have become so universal in Persia, and which have converted many a wilderness into a fertile plain. Subterranean aqueducts or *kanats*, sometimes many miles in length, which are employed to convey water beneath arid tracts of land, have a double advantage : they not only reduce loss from evaporation to a minimum, but, inasmuch as they are nearer the underground water-level, little of their water is lost by drainage into the ground. It is always curious to note how similar inventions have been independently made in different parts of the world. The ancient Peruvians constructed subterranean watercourses on a noble scale in connection with their gigantic works of irrigation (one traversing the district of Condesuyu measured 400 to 500 miles), and, like the Persians, had laws prescribing the quantity of water which individual landowners might be permitted to draw (*Prescott*). The waters of the Persian kanats contain the ordinary chub, *Capoëta*, and *Leuciscus* of the rivers ; and the dark-vaulted spaces are often the abode of great numbers of bats.

The chief crops cultivated are cereals, vines, castor-oil, tobacco, melons, rice, and cotton. The fields are so level, and so well trenched, that they can be watered by a simple diversion of an irrigation channel.

Vegetation.—Perhaps the most noticeable feature of the vegetation of the Urmi plateau is the almost total absence of indigenous, uncultivated trees. And yet in some parts the landscape can only be described as thickly wooded. The villages are often completely hidden by trees grown for fruit or fuel. There is no lack of all manner of fruit trees: apples, pears, quinces, apricots, peaches, nectarines flourish in the gardens round the villages; willows and poplars line all watercourses; planes, walnuts, and jujubes form avenues along roads; but all indigenous trees have long since been cut down. It is not the case that the conditions would be unsuited to the growth of arboreal vegetation, because they are much the same as those prevailing in the oak-forest districts in Turkish Kurdistan.

By roadsides and in villages the plane (*Platanus orientalis*, L.) is often planted, for the sake of the shade afforded by its spreading branches. Here and there a giant has been spared, and has become regarded as a holy tree. Chardin refers to one in a garden near Shiraz upon the branches of which amulets, rags, and other votive offerings were hung. The Rev. S. J. Daltry observed a similarly decorated tree near the sulphur-springs on the hills to the north of the plain of Gavilan. There is an enormous plane in the village of Dekhargan growing over a water-tank, which is reached by some steps descending between the buttresses of the tree. Close by are three ancient Mussulman tombstones rudely carved like the quadrupeds of our Noah's-arks. Beneath the same tree stands a stone bench used as a castor-oil press. It is a pity that more of these magnificent trees are not planted by the present generation, who, although ready enough to gain advantage by the good deeds of their forefathers, are too idle to follow their good example.

I did not see any specimens of the Oriental plane or of the walnut (*Juglans regia*) which could unhesitatingly be described as wild or indigenous in the Urmi district. I am therefore inclined to consider that Dr. Radde's * dictum that all planes and walnuts in the Caucasus have been planted by man, with the possible exception of the walnuts of Gilan, is equally true of the Urmi district. I saw a few walnut-trees on the islands of Koyun and Arzu, in the Lake, which might be regarded as indigenous. The largest was a stunted tree of about 15 feet

* G. Radde, 'Reisen an der Persisch-Russischen Grenze,' 1886.

in height, with a stem 2–3 feet in diameter near its base. It is, however, equally possible that the trees were planted when the islands were inhabited and joined to the mainland. Formerly the larger islands seem to have been fairly thickly wooded, but the fuel-collector has not only cut down the trees with an unsparing axe, but now the sailors of the ships earn a living by eradicating all trace of their existence by laboriously digging-out their very roots. Walnut-wood is in great request for the best joinery and cabinet-making.

The banks of the watercourses are recognizable from afar on account of the poplars and willows planted along them. The willows are generally pollarded at regular intervals of time. The long straight poplar poles are used as rafters for the roofs of houses and balconies. Split laths are laid transversely from rafter to rafter, matting is laid on them, then hay, and finally a thick layer of mud and chopped straw.

Geology of Urmi Basin.—The Azerbaijan lake-basin occupies an area of some 20,000 square miles; its greatest depression is more than 4000 feet above sea-level. The mountains on its periphery separate its water-system from the circumjacent basins of the Tigris, the Aras, and the Kizil Uzun, the latter two of which flow into the Caspian Sea. Several peaks rise above 10,000 feet, and the volcanic cone of the Savalan reaches 15,000 feet. Outcrops of volcanic rock occur in many localities, and probably had their origin during the vast upheaval of land which occurred after the Miocene age.

The geological record of Lake Urmi is still but very partially read. The oldest rocks are Palæozoic and probably of Carboniferous Limestone age, because the genus *Endothyra* is to be detected among their Foraminifera (p. 452). The Jurassic age is represented by a solitary Ammonite in my collections (p. 418); but Rodler, von Borne, and others have noted several localities near the west coast of the Lake of Urmi where Jurassic rocks are to be found. For the palæontology of the later deposits, I would especially refer the reader to Mr. Bullen Newton's comprehensive retrospect on p. 430.

The Carboniferous rocks of the Lake itself are overlaid by a great thickness of Miocene chalk, an important section of which is referable to the Helvetian period, and which contains the remains of organisms identical with those of the Lower Miocene (pp. 430–452). The North Persian Tertiary rocks are divisible

into three well-characterized equivalent zones, which have been defined by Pohlig as :—

Zone 1. The marginal zone of sandstones, conglomerates, and gravels, often containing organic remains from earlier strata. The Seir hill probably belongs to this zone.

Zone 2. Light-coloured marls, generally bright red, with beds of rock-salt and gypsum. Both zones 1 and 2 take a large part in the formation of the hills of the Persian plateau.

Zone 3. Limestones and calcareous marls; best seen in the islands in the Lake of Urmi, but also in the mountains to the south-west, and which are very rich in molluscs, reef-building corals, and silicious sponges.

At Guverchin Kala, near the northern end of the lake, the entire series of Miocene strata rest almost horizontally and directly on red granites traversed by felspar-dykes, which are a very conspicuous feature in the landscape.

Urmi must therefore have been covered by a sea of normal salinity in Miocene times, which was apparently an extension of the Miocene Mediterranean Sea. Then commenced those vast changes of level which resulted in the upheaval of a Miocene sea-bottom some 5000 feet to its present position as part of the Persian plateau; this vast earth-movement is still clearly recorded by the numerous volcanoes and outbursts of volcanic rock which, monument-like, mark the spots where the earth-crust gave way before overwhelming strains and irresistible pressures. The next chapter in the story of Urmi tells us how at a later date the dry land about Maragha supported a mammalian fauna, which must have been very similar to the almost contemporaneous fauna of Samos and of Pikermi in Greece. The bones of herds of elephants, antelopes, and horses, as well as those of many other mammals, are to be found preserved in the pumiceous tufa-deposits of Kirjawa near Maragha (p. 376); it is still uncertain whether or not the animals perished in consequence of a volcanic eruption or from some other cause.

During Pliocene and post-Pliocene times the land undoubtedly underwent considerable changes both of level and of contour. There is no evidence that the present lake is the remains of a Miocene sea, and therefore it is not to be regarded as a "Relikten-See," a view which is also shared by Rodler. The excellent American monograph on Lakes Bonneville and Lahontan is an example of how the physical geographer has been able to reconstruct

former lake-basins by an examination of terraces and of sinter and travertine formations; but in the case of Lake Urmi neither were the investigations of Loftus or Rodler rewarded by the discovery of lake-terraces, nor do the travertine deposits of Dashkiesen appear to be of lacustrine origin. The travertine deposits round Lake Urmi seem to be the result of mineral springs. Pohlig mentions Pleistocene flood-zones of *Neritina* and *Dreissena* on the islands and on the Shahi peninsula; but although I saw a single specimen of a *Dreissena*-travertine mass in Urmi, I was not able to discover where it had been found, and consequently I was not able to confirm Pohlig's theory.

Lake of Urmi.—The lower parts of the depression of the Azerbaijan plateau are covered by the great salt-lake of Urmi. The length of this sheet of water, as measured from north to south, does not fall short of 80 miles, and its breadth is about 25 miles at the wider parts, but is far less where the Shahi peninsula, jutting out, lessens the distance to ten miles. In former days the mountain of Shahi seems to have been entirely surrounded by water, but now it is connected with the eastern shore by dry land except when the spring floods convert the isthmus into a marsh. The area covered by the lake is about 1750 square miles.

The shores of the lake, in some few places where the hills come down to the water's edge, are rocky, and falling away abruptly exhibit low cliffs of erosion; but for the most part the land slopes so gradually that the bather may have to wade for a mile or two before he reaches water which is out of his depth. The more notable elevations on the coast-line besides Mt. Shahi are at Guverchin Kala, a promontory of granite with pink felspars and of Miocene limestone with shells and echinoderms, near Gavilan; at St. George's Hill, Superghan; and at the Bezau Daghi, which are at any rate partly of volcanic origin, since their lower flanks are composed of pumiceous hornblende-biotite-andesite.

The islands will be described in greater detail below. There are a few small islets off Guverchin Kala, at the northern end of the lake, which I was unable to visit; but the more important group of islands is situated in the southern half of the lake, though its exact geographical position has yet to be defined.

The depth of the lake is inconsiderable. At no place does this huge expanse of water appear to be more than 40 feet in

depth, and it is doubtful whether the average sounding would be as much as half this; indeed, it seems to me to be probable that 15 feet would more nearly represent the mean depth. As in other salt lakes the height reached by the water is liable to considerable seasonal variation; the difference of level seems to bear such a large proportion to the average depth of the lake that the composition and specific gravity of the water must undergo very considerable alteration during the change from the dry-season level to that of the wet-season. It might be quite possible to compute the total volume of the lake from the data supplied by gravimetric measurements considered in relation to the easily measurable increase of volume after the rainy season.

The specific gravity of a sample of water obtained on September 16, 1898, was 1·1138 at 15° C. Its salinity was equal to about $\frac{3}{5}$ of that of the Dead Sea (sp. gr. 1·2225 at 120 metres, *Lartet*).

A chemical analysis of the filtered water, undertaken for me by my friend Mr. J. J. Manley, gave the following proximate results, calculated in parts by weight in 100 grammes of the solid salts:—

Sodium chloride	86·203
Magnesium chloride	6·816
Magnesium sulphate	3·915
Calcium sulphate	1·151
Potassium sulphate	1·741
	99·826

·017 per cent. of free carbonic acid gas was also present, as well as an unweighable trace of barium. The weight of the total solids came to 14·893 parts in 100 of the water *.

The average temperature of the water during the month of August was about 80° F. at the surface and some two degrees lower at the bottom (depth 25 feet). The very shallow water very near the shores was of course heated up to a higher temperature (82° F.), and was far more concentrated by evaporation than the open lake-water: in many places along the margin the

* For further details concerning the chemical and physical characters of the water, see a paper by R. Günther and J. J. Manley, "On the Waters of the Salt Lake of Urmi," in Proc. Royal Society, 1899, vol. lxv. pp. 312–318.

concentration of the saline solution had become extreme, and the salts were being deposited upon the surface of the loathsome black mud, reeking of sulphuretted hydrogen and probably yielding marsh-gas as well, which seems to be such an inseparable feature of salt lakes. For some distance from the water's edge the foreshore was covered with a dazzling crust of white salt.

The salt water has a very unpleasant physiological action upon all the mucous membranes, and produces nausea if swallowed, but is otherwise innocuous to the bather. The Syrians are in the habit of bathing in the lake upon St. Thomas's day (July 3rd O.S.), in order to commemorate the tradition that the Saint crossed the lake on his way to India. On emerging from the water the skin becomes rapidly covered with a thin crust of salt, unless the water be rapidly removed with a towel. But although harmless and even invigorating to man, the salinity is fatal to any freshwater fish of the rivers which may happen to swim out too far; wherefore at the present day the lake forms a very efficient barrier to the distribution of fish from one river to the next. Quantities of dead fish may sometimes be seen near the mouths of some of the rivers. I tried the experiment of putting freshly-caught chub into the salt water, and found that they died in three and a half minutes. When the salt water was gradually substituted for the fresh, the fish died when the mixture contained about a third of the salt water, which was at the end of forty minutes. On the 2nd of August a specimen of the green tree-frog was found vainly endeavouring to escape from the salt water into which he had accidentally jumped; but his rapidly weakening efforts showed that he too would soon have become a victim of the salt water, and have involuntarily verified Semper's observations ('Animal Life,' p. 150), had he not succumbed to the collector's alcohol.

Plankton.—It might very naturally have been supposed that so hostile an environment as a strong saline solution, surrounded by a zone of a still stronger one almost saturated with sulphuretted hydrogen, would have been incompatible with organic life. The Lake of Urmi, however, is in no sense of the word a Dead Sea: it is simply teeming with living organisms, both animal and vegetable. Whether near the shore or miles from it, the clear water may be seen to sparkle in the sunlight owing to the enormous numbers of organisms which constitute its plankton. Throughout all the vast volume of water the distribution of life

seemed to be fairly uniform, for even water drawn from a depth of 28 feet contained its due proportion.

In the month of August the vegetable portion of the plankton consists of small green masses, either of a globular or of a membranous, flat and irregularly expanded form, of soft or gelatinous substance, and varying from $\frac{1}{10}$ to $\frac{3}{4}$ of an inch in diameter. I at first regarded them as simple colonies of algæ; but Mr. G. Murray, who has been kind enough to examine my all too scanty material, assures me that their structure is that of a bacterial zoogloea of micrococci invested by a number of small diatoms.

Their presence in such enormous quantities in the lake makes me suspect that there may possibly be some more intimate vital relations between the two organisms than would appear at first sight. Their abundance in parts of the lake where there is unlikely to be a proportionately large food-supply for plants of holozoic nutrition, seems to indicate symbiotic relations between the chlorophyll-containing diatoms and the bacterial colonies, of a nature very similar to those which enable the constituents of the lichen to maintain life in situations where life would be impossible without such a symbiosis. At the same time, it is possible that the colonies may feed upon matter brought down by the rivers, and that they may owe their universal distribution to the surface-drift of the waters caused by the wind.

The vegetable portion of the plankton affords nutriment for the fauna. As I have already stated in my letter to 'Nature' of Sept. 8, 1898, the so-called "jellyfish" alluded to by Lord Curzon of Kedlestone and Mr. P. L. Sclater is a species of brine-worm allied to *Artemia salina*, Leach. In the shallows near the muddy shores are to be found the aquatic larvæ of a Dipterous insect not unlike the larvæ of *Ephydra riparia*. As in the rat-tailed larvæ of *Eristalis* and of *Ptychoptera paludosa*, the respiratory tubes are prolonged posteriorly and admit of considerable extension, so that the larva is able to draw air into its tracheal system while crawling in search of food beneath the surface. The extremity of the respiratory tube is forked, and each branch is tipped with small hairs which naturally increase the clinging power of the apparatus to the surface-film of the water. The larvæ were about 10 mm. in length.

The little brine-worms (*Artemia urmiana*) were as a rule uniformly distributed throughout the lake, but clouds and streaks

of *Artemia* are occasionally to be seen at certain places near the shore. In such streaks in which the Artemias were more than ordinarily numerous, there were always a large proportion of dead individuals or of individuals with impaired swimming powers; the greater density of their aggregation seemed to be the result of local currents. In the clear green waters brightly illumined by the sun, the delicate cuticles of the Artemias sparkle like star-spangles. In order to obtain data for comparing the density of population of Lake Urmi with that of other lakes, a tow-net of silk bolting-cloth (meshes ·25 mm. square) was slowly drawn horizontally through about 35 yards of water in the middle of the island archipelago, and again in a vertical direction through 25 feet (the utmost obtainable at the station); the organisms captured were put into alcohol, their numbers were counted and their apparent volume measured. The two horizontal fishings gave results not differing from the mean by more than 3 per cent. The cubic metre of water was found to contain 1577 individual Artemias—or roughly, an Artemia to every pint of water. The preserved material, after being allowed to settle for 24 hours, occupied an apparent volume of 42·5 cubic centimetres. The vertical fishings gave rather lower results. Six hauls of the plankton-net showed that the average vertical distribution was about 1203 Artemias to the cubic metre of water. The inference is that, although the population is less dense near the bottom than near the surface, yet on the whole the organisms may be said to be fairly uniformly distributed throughout the lake. My observations are therefore in accordance with those of Reighard made during a biological examination of Lake St. Clair *.

The fishings recorded above were made at 8 o'clock in the morning, but others made at midnight (with strong moonlight) and at midday showed that there does not seem to be any extensive diurnal migration of the kind which Forel has shown to be characteristic of the pelagic fauna of deep fresh-water lakes, and which is also usual with many marine pelagic animals. Indeed, during the day, owing to the shallowness of Lake Urmi, the bottom is not much less brightly illuminated than the surface, and a fauna of negatively heliotropic nature would search in vain for twilight in its inconsiderable depths. I am of opinion, therefore, that 1200 Artemias per cubic metre

* Bull. Michigan Fish Commission, 1894, No. 4.

is a fair estimate of the density of the population. If it be assumed that the average depth of the lake is 6 metres, the total population of the 1750 square miles of lake must be at least 39×10^{12} adult individuals.

The eggs of the Artemia may often be seen floating on the surface in long, interlacing streaks of a brown colour. The Artemias and their eggs are indubitably the food of the great concourse of water-fowl which have been remarked by all travellers as dwelling on the shores of the lake. In August I saw no flamingoes, although quantities of their pink feathers on the beaches testified to their presence earlier in the year. Gulls and ducks were very abundant.

Influence of a Saline Environment.—It appears that although the water of Lake Urmi is not incompatible with the well-being of all organic life, yet its salinity is too great to admit of the existence of more than a few species. They are on the whole similar to the species described from other salt lakes in desert regions, but the fauna is rather more limited. Lake Urmi, in respect of its fauna, is very similar to the Adschidarja, near the Caspian Sea; it does not contain so many species as the less saline pools of the neighbourhood of Odessa (*Schmankewitsch*), nor do any Coleopterous insects appear to have become acclimatized to its waters as has happened in certain American and European salt waters. It is possible that a worm may yet be found living in its waters, as *Pachydrilus* does in the strong brine-springs of Kissingen (*Semper*) and Kreuznach (*Claparède*). The affinity of the Urmi fauna is undoubtedly with that of the fresh-water rather than with that of the sea; the fauna is therefore not to be regarded as *halolimnic* in Mr. J. E. S. Moore's sense of the word: it is decidedly *halophilous*.

The influence of a strong saline solution upon the structure and habits of an organism has engaged the attention of several naturalists. The early researches of Plateau and Beudant proved that many freshwater animals will live in sea-water and *vice versa*, so long as the change from one to the other be not effected too suddenly; and also that different animals have different powers of resistance to such a change. In 1889 Boas* described the remarkable changes of structure which occur in *Palæmonetes varians* in accordance with its growth in fresh or salt water. The last few years have produced

* Zool. Jahrb. iv.

an abundant crop of literature dealing with the effect of salinity upon the early stages in the development of organisms and especially of Echinoderms (Morgan, Loeb, Rawitz, Norman, Vernon, and other students of "Entwickelungsmechanik"). None, however, are of more importance than the classical treatises of Schmankewitsch upon *Branchipus*, *Artemia salina*, and *A. Mülhausenii*. By some accident a tank near Odessa became filled with salt water of a density of 1·0567 (8° Beaumé) in 1871. The water in the tank became concentrated by very gradual evaporation until in 1874 it reached a density of 1·2015 (25° B.). The *Artemia salina* which populated the tank in 1871 underwent a gradual change as the salt water became more and more concentrated. The setæ of the furcal lobes of the tail became fewer in number and dwindled in size, the gill-lamellæ enlarged and altered in shape, the abdomen tended to alter its segmentation, and finally the entire species became metamorphosed into *A. Mülhausenii*, a species only known from the most saline waters.

The *Artemia urmiana* lives in a far more saline water than the *A. salina* of Schmankewitsch did, but not in such a saline solution as *A. Mülhausenii*. Consequently we should expect *A. urmiana* to be intermediate in structure between these forms in those characters which are determined by the strength of the saline environment; and this is precisely what I have found to be the case with respect to the tail-lobes and their setæ. Many of the *Artemia urmiana* exhibit clearly the intermediate condition figured by Schmankewitsch on plate vi. fig. 5*, The specific gravity of the water which produced this condition in Schmankewitsch's experiment was about 1·1373, while the specific gravity of the water of Lake Urmi is 1·1138, or ·0235 lower. It must be remembered that the salinity in the ponds of Schmankewitsch was increasing at a very rapid rate as compared with the rate of change of the salinity of Lake Urmi. It is therefore likely that if the Artemias of Odessa had had more time, as measured by *Artemia*-generations, in which to adapt their structure to a salinity indicated by a specific gravity of 1·1138, the resemblance between the Russian and Persian Artemias would have been even yet more striking. Even as it is, the Artemia seems to act as a hydrometer with an error of less than ·03 in the determination of specific gravities.

* Zeitschr. f. wiss. Zool. 1875.

Islands.—In the southern half of the lake is a small group of rocky islands which from a distance present a rounded appearance, like the knolls on our chalk downs, but from a nearer point of view their precipitous cliffs and rugged hill-sides testify to the erosive powers of the heavy salt waves in stormy weather. Their geological structure has been investigated by Abich, who pronounced them to be built of Miocene chalk resting upon Palæozoic calcareous strata which are to be seen near the north end of Koyun Daghi. The Miocene chalk is divisible into three main divisions. The uppermost is porous and contains *Ostrea Virleti*, Deshayes; the middle division is of a more compact nature and is rich in corals. In the lower deposit bivalve and coral fragments are found, together with *Turritella Archimedis*, Brongniart, *T. turris*, d'Orb., and *T. gradata*, Menke.

On many of the islands are beaches of shells, coral fragments, and echinoderms, organisms which could have lived only in a sea of marine salinity and in connection with the ocean. These marine reliquiæ, now for a second time rolled by salt waves, tell the tale of a Miocene sea of normal salinity which has been supposed by Pohlig to have been a northerly continuation of the Persian Gulf from the Indian Ocean, but which, as already stated, was more probably an extension of the Mediterranean. This Miocene sea, like the Red Sea of to-day, was a coral sea. Upon its floor were laid down the chalk and limestone formations of the Urmi Archipelago, as well as those of the calcareous mountains to the south of the lake.

The largest of the islands are Koyun and Arzu, of which the former measures between 3 and 4 miles in length and rises to a height of about 1000 feet above the level of the lake.

The islands appear to have been formerly inhabited, and there may still be seen foundations of houses near a spring at the south-eastern end of Koyun Daghi. At the present time they are uninhabited, but are often visited by sailors, who turn out goats and sheep to pasture on them during certain months in the year, and who not only cut down the trees, but even dig up for fuel the roots of trees felled by their predecessors. There is a tradition that some eighty years ago the islands were connected with the mainland by a causeway which can, it is said, still be detected by sounding. This tradition is certainly confirmed by the zoology of the islands. There are at least five species

of land-shells and two species of lizards (*Eumeces Schneideri* and *Ophiops elegans*), which would be very unlikely to have crossed the broad expanse of water separating the islands from the mainland. There were also mollusks, woodlice, scorpions, *Galeodes*, and several wingless insects.

The most interesting feature of the fauna of these islands is that upon them once lived a wild sheep, a distinct variety, apparently allied to the Cyprian *Ovis ophion*. Unfortunately, I brought home only one skull, although there was an entire skeleton upon Koyun Daghi. It is possible that this sheep, too, may belong to a "Relikten-fauna," if I may be permitted to apply Credner's term to a terrestrial area.

Some eagles (probably *Aquila chrysaëtus*, L.) breed among the highest crags of Koyun Daghi, and the lower crannies are the homes of countless rock-pigeons. The shores are often lined with ducks and gulls, which feed on the crustaceans (*Artemia*) and bacterio-diatom colonies of the Salt Lake. On the pebble-beaches I picked up many pink feathers of the flamingo, but I did not see any of the birds during my stay; they are abundant in winter, and are snared on the mainland in spring. Some of the beaches are covered with reed-stems, which have probably been drifted across from the mouths of the great southern rivers by southerly winds. Partridges and quails were occasionally heard, and magpies were to be seen at the spring disputing with the pigeons for the right of drinking first.

Upon the small grass-grown Shazalan Island, to the north of Arzu, I saw two young specimens of *Eumeces Schneideri* as well as many *Ophiops elegans*. Myriads of rock-pigeons which nest in the crevices of the rocks are regarded by the sailors as an unfailing source of pigeon dinners. The rocks consist of a dark slate-coloured limestone, with many crevices and cavities containing secondary depositions of calcium carbonate. The limestone is very similar to that of the N.W. end of Koyun Daghi, and is of Carboniferous age.

The vegetation growing on the islands at the time of my visit was mostly burnt up by the sun except near the springs. On Koyun and Arzu there are a few stunted walnut-trees, the largest of which measured between two and three feet through at a yard from the ground. The calcareous soil favours the growth of the *karuan* plant (*Artemisia*): the effect of its aromatic odour as an

insectifuge is as well known as it was in the days of our forefathers, when the housewife was taught that—

> "Where chamber is swept, and wormwood is strewn,
> No flea, for his life, dare bide or be known!"

Plains.—The shores of the lake are for the most part surrounded by gently sloping gravel or alluvial plains, which extend as far as the feet of the hills. They are traversed by the numerous rivers which flow into the lake, and which distribute their waters among innumerable villages and over vast tracks of cultivated land. When seen from a distance the irrigated fields look like extensive forests, owing to the poplars and willows which line the watercourses, and which doubtless have given rise to the misleading statement that Lake Urmi is "surrounded by wooded shores and hills" (Curzon, 'Persia,' p. 532).

The country which is too far from water to be irrigated is of the nature of a thistle-covered steppe, whereas the lower marshy portions exhibit rank growth of rushes and blue irises.

My first impressions of the Zoology of the Urmi plains were of disappointment, and for two reasons—firstly, because the general facies of the fauna is pre-eminently European, and, secondly, because I found the country much more densely populated than I had expected. There are villages wherever sufficient water is obtainable to make agriculture possible; and as these villages have existed for very long periods of time, within their spheres of influence, Nature has been tamed and the fauna profoundly changed.

Among domesticated animals the most striking are the camels, buffaloes, and fat-tailed sheep (*Ovis steatopygus*). Buffaloes only do really well where they can spend several hours a day in the water. When water deep enough for complete immersion cannot be found, a small boy is often told off for an hour or so to bale up water in a pot and to pour it over their backs. The winter on the Urmi plateau is so severe that the buffaloes have to be kept in stables until the return of warm weather.

The gazelle (*Gazella subgutturosa*) doubtless once lived on the plains of Urmi, but has now become exterminated by the spread of cultivation. The badger (*Meles canescens*) is rare. The rats and mice are unknown to science, although their holes are common in the fields and along watercourses. A species of gerbille occurs, but is not very common.

Quails and partridges are common, and afford a favourite sport to native falconers, who use sparrow-hawks. The bee-eaters (*Merops apiaster*) were extremely plentiful near the northern end of the lake in July, but were not to be seen further south in August and early September.

Storks are abundant; their twig nests are to be found in trees or on the roofs of the houses in most of the villages. The Syrians have learnt the Persian story that the stork visits Mecca during his winter migration, and doubtless that is why "Hajji Laqlaq" is regarded as bringing good luck and is attracted by nesting-baskets put up in trees. Storks return about March 14th.

The hoopoe is common. The Syrians consider them unclean birds (Lev. xi. 19, R. V.; Deut. xiv. 18), and call them "Pupu" and also "Birds of Solomon," from the old legend that they got their crests from him. "A flock of them once sheltered him from a burning sun. In gratitude the king asked them what he should do for them, and they asked for crowns of gold. But finding that they were being killed by greedy men for the sake of the crowns, they begged Solomon to change them for the crest which they retain to this day" (*Maclean*).

In addition to the reptiles mentioned below, *Clemmys caspia*, de Filippi, is common. Many may be seen walking along the banks of the watercourses, ready to dive into the stream on being disturbed. After lying still for three to five minutes in a hole or beneath some water-weed, they cautiously come up to see whether the danger is past. All the specimens examined had the yellow sternal shields with black patches characteristic of *C. caspia* as opposed to the European *C. leprosa*.

Testudo ibera is common at Seir, as indeed it is on the mountains to the east of the lake. On Koyun Daghi I found the fragment of a carapace which probably belonged to this species.

Fish.—Inasmuch as the rivers which flow into the lake are separated from each other by a medium, the salt water, in which no fish can live for a period long enough to enable it to swim from one river to the next, the characteristics of the fish fauna of the individual rivers are deserving of the most careful investigation, because they may supply us with a clue to the physical conditions which obtained during a particular epoch in the lake's history. If it can be shown that the faunas of all the rivers are identical, or that no local variations or species are distinguishable in the different rivers, then it must be inferred that the rivers

have not been isolated from each other long enough for such faunistic differences to have appeared. But if, on the other hand, it can be proved that there are faunistic differences between the rivers, then it must be inferred either that the rivers have been populated from different stocks, or that they have been populated from the same stock at so remote a period that their isolated faunas have had time to become modified in different directions.

My collections and observations are by no means as complete as could be desired for the solution of the problem, but still they would seem to afford a strong indication of the existence of local faunistic differences in the rivers. I think they show that there are not only differences of species and varieties, but that the relative abundance of the common species varies greatly in the different rivers.

As I have already pointed out, the rivers which flow into Lake Urmi may be divided into three groups*. The Zola, Nazlu, Shaher, Barenduz, and Gader rise in the mountains to the west of the lake; the Tatawa and the Djaghatu enter the lake from the south; and the Murdi, Safi, and Adji receive the eastern drainage.

Probably all the rivers contain the chub, *Capoëta gracilis*, and an *Alburnus*. The Gader, Tatawa, and Djaghatu are noted for the *Silurus glanis* which is absent in all the western series of rivers except the Gader Chai, which opens near the Tatawa, and which probably often mingles its flood-waters with those of the latter stream on the flat land between their mouths. *Leuciscus ulanus* seems to be peculiar to the waters of the Plain of Salmas, and *Leuciscus gaderanus* to the southern rivers. I succeeded in catching *Barbus caucasicus* and *Nemachilus persa* only in the more northern streams, although the former is common all over Persia.

Most of the fish procured were taken by means of poison, a method of fishing which, so far as its efficiency and unsportsmanlike character are concerned, is second only to the method of fishing with dynamite. A mixture of flour and the pounded berries of *Cocculus indicus* is mixed with sufficient butter to make a stiffish paste. A backwater or reach where the stream does not flow too rapidly is then ground-baited with small pellets of the paste. If the fish are feeding, the poison will begin to work in about ten to fifteen minutes; and the poisoned fish will

* 'Proc. Roy. Geographical Society,' vol. xiv. pp. 504–523.

begin to swim in small circles at the top of the water, and may be taken in a landing-net. Many which have eaten much of the poison will swim into the bank and lie helpless in the shallow water. If the river is at all full of fish, a great number may be caught with a surprisingly small quantity of poison. On September 9 I mixed about six ounces of the poisoned paste and ground-baited the Tatawa Chai near Sujbulak. We took 38 Capoëta and chub of five ounces and upwards, and both sides of the river were silvered by lines of poisoned smaller fish for a distance of about a hundred yards.

The fish which have not eaten much of the poison gradually recover, and regain the power of coordinating their movements. The dead fish which are too small to be worth picking up by the villagers, who always turned out in crowds at the mere mention of fishing, are soon devoured by the crabs. If the poisoned fish be carefully cleaned, they have no bad effect when cooked and eaten.

The large rivers which flow into the lake from the southern end —the Djaghatu Chai, Tatawa Chai, and Gader Chai—are stated by the natives to contain "whales" whose ancestor swallowed Jonah. The "whales" turned out to be *Silurus glanis*. They are caught either by being driven into nets or by the gaff. A Jewish fisherman accompanied me to a place near Ocksa, where the Gader Chai has cut a deep channel under a bank overgrown by willow-trees. After divesting himself of all needless clothing, he dived into the deep water with his gaff, and hooked about among the willow-roots at a depth of about 4–5 feet. After eight minutes he succeeded in gaffing a large female Silurus 3 feet 9 inches in length, and before a quarter of an hour had elapsed he had three fine fish out on the bank. He told me that the largest "whale" he had ever seen was about five feet long. They spawn in deep pools below the willows, where the water runs slowly, about one and a half months after the melting of the snow. The Silurus is eaten by Armenians, but is unclean to Jews and Mahomedans on account of the absence of scales on its body.

I was informed that the Governor, when he wishes to do honour to a guest, organizes a "whale" hunt, and all the villagers assist at the "tamasha." The buffaloes of several villages are turned into the river and are made to walk upstream for a couple of miles, with the result of driving the fish before them. At a suitable place, a line of men with nets stand prepared to catch

all fish driven in their direction; and in this way several hundred "whales" may be caught amid the din of the exhortations of the enthusiastic onlookers, who often cannot refrain from rushing into the water and from joining their struggles with those of the splashing fish.

Invertebrata.—The most conspicuous member of the freshwater invertebrate fauna is the freshwater crab, *Telphusa fluviatilis*, which may be found under stones in burrows, part in and part out of the water. Always on the look-out for carrion, these scavengers were frequently seen trying to drag poisoned fish from the margin of the stream to some more retired nook in the deeper water.

In clear spring-beds *Gammarus pulex* was often met with, but *Asellus* seemed to be entirely absent; and by its absence the pond-life afforded a very striking contrast to that of Europe within the range of *Asellus*. Leeches and planarians were common.

My small collections of terrestrial invertebrata have been examined by Messrs. Edgar Smith, Butler, Pocock, Burr, and Sir G. Hampson, and are described below.

The traveller in Persia is always interrogated about "insect" pests, and consequently a few words upon them may not be out of place. Mosquitoes are painfully abundant in the Araxes plains both in Russian and in Persian territory. I was not troubled by them at all in August and September, either at Urmi or in any of the villages at some distance from the lake, although I always slept on balconies or housetops without any protection to the face. On the other hand, in the country near the lake, as at Superghan and Ardishai, they are said to be intolerable during September.

The much-dreaded *Argas persicus* is not rare, but its venomous bite does not appear to be followed by the fatal or fabulous consequences often attributed to the bug of Mianeh, where, according to Maurice Kotzebue, a victim "éprouva bientôt dans tout son corps une chaleur violente, tomba dans une espèce de délire, et expira enfin au milieu d'épouvantables convulsions." The native cure is the application of the still smoking skin of a newly-flayed ox to the seat of the evil.

Scorpions are common, but are rather local. Many Persians are familiar with the old story of the scorpion which, when

surrounded by a circle of live coals and unable to escape, stung itself in the head. Dr. Wills ('The Land of the Lion and the Sun,' 1891, p. 249) even asserts that he has witnessed the suicide of fire-girt scorpions on more than one occasion. Unfortunately Dr. Wills does not designate the particular kind of scorpion with which his experiments were performed. A solitary experiment of my own, made with *Buthus caucasicus* subsp. *persicus* at Maragha, proved as unsuccessful as those which were undertaken by Prof. Ray Lankester.

The sting of scorpions is greatly feared, and peculiar precautions are taken against them in many places. Many stories are told of deaths attributed to scorpions, but it is always difficult to ascertain whether the venom was the sole cause or merely an accompanying complication. However, it is certain that scorpion stings are better avoided. In some parts dried thistles, spread loosely under the beds, are employed in order to keep scorpions away: indeed, many of the mountain folk of Kochanes hold that a goat-hair blanket will suffice for this purpose; since scorpions have such a tender skin on their stomach that if they can be made to walk over the hair of a goat, they will receive a "mortal wound."

Mimicry.—On August 19 I noticed some interesting cases of what appeared to be protective coloration. Near the spot where the Shaher Chai leaves the hills and enters upon its course across the plain of Urmi, numerous poplar trees have been planted. The bark of the *Populus alba* is on the whole of a grey colour, the ground being dark and sprinkled with light-tinted, almost white stippling. Upon the bark of the trees were several species of insects which so exactly mimicked the bark upon which they were sitting that it was extremely difficult to distinguish them from their background (Pl. 27. fig. 1). The insects found upon the poplar bark were *Yponomeuta padellus*, L., *Pentatoma baccarum* (?), and *Bathyoscopus poceilus*, H.-Sch. There were also numerous spirally coiled shell-like larva-cases or cocoons of *Apterona crenulella*. No other insects except ants were seen. The *Pentatoma*, with its grey speckled thorax and wing, and with its antennæ barred alternately white and black, was more invisible against the grey bark than its emerald-green relative was upon the fresh green leaves of herbaceous plants near the stream.

Seir.—The chief locality in the hills at which collections were made was near the small village of Seir, 5–6 miles W.S.W. of Urmi. It is situated at a height of some 1460 feet (*Loftus*) above the level of the lake, on the eastern slopes of the Seir Dagh. Here a gravel, conglomerate and sandstone hill rises to a height of 7260 feet above sea-level; its strata dip to the east and overlie the limestone of the plain of Mergawar. From Seir there is a fine view over the wide cultivated plain of Urmi to the deep blue lake, interrupted only by the triple-crested Bezau Daghi and the conical hill of Superghan; and when the mountains on the further side of the lake are covered with snow, the prospect must be indeed superb. Here, as it were on the dividing-line between the rich cultivation of the plain of Urmi and the barren wildness of the Kurdish hills, the Christian Missionaries seek the healthful fresh mountain air when the noisome summer heats of the city become unendurable, and exchange an artificial environment for a natural one.

The hillsides have been dissected by the rain-water torrents, and many a section has been laid open for geologists. The uncompacted sands and gravels which intervene between the more coherent conglomerates and sandstones are rapidly removed by the spring torrents, and the compacter rocks fall away and litter the stream-beds with great boulders which may measure a score of feet square and half as many through.

The pebbles in the conglomerates, consisting of both igneous and calcareous rocks, have not as a rule been very thoroughly rounded, and therefore appear to be of a fluviatile rather than of a sea-worn origin. I was quite unable to discover any organic remains coeval with the conglomerates; but many of the pebbles are of older, fossiliferous formations. Especially abundant were limestone fragments containing three or four species of corals, while others with shells were occasionally met with. The igneous rocks consisted of granites and felsites.

Seir Vegetation.—In August the vegetation covering the hillsides above the village of Seir was burnt to a dull yellow hue by the summer drought. It was always a subject of wonderment to me how flocks and herds pasturing on such barren-looking slopes could manage to pick up a living. Earlier in the year the hillsides are green and gay with white and pink crocuses and irises; but in August the most conspicuous plants were large blue thistles, dwarf yellow hollyhocks, yellow-green euphorbias, not unlike our

own species but larger, and yellow everlastings, and here and there a few Daphne bushes *.

I am indebted to Dr. O. Stapf, the authority on Persian Botany, for the identification of the following species. The list has no pretence to completeness ; it is merely intended to give an idea of the general aspect of the flora in the latter half of summer :—

Farsetia suffruticosa, DC.
Scabiosa olivieri, Coult.
Cephalaria sp.
Xeranthemum squarrosum, Boiss.
Helichrysum armenium, DC.
—— *aucheri*, Boiss. (?).
Centaurea virgata, Lam., var. *squarrosa*.
Lactuca orientalis, Boiss.
Campanula sp.
Podanthum sp.
Acantholimon sp.
Odontites aucheri, Boiss.
Ziziphora clinopodioides, M. B., var.
—— *rigida*, Boiss.
Thymus kotschyanus, Boiss. & Hoh.
Teucrium polium, L.

In moister situations on the sides of a small stream from a spring were :—

Glycyrrhiza glabra, L.
Eryngium billardieri, Laroch, var. *meiocephalum*, Boiss.
Echinops sp.
Pulicaria dysenterica, Gaert., var. *microcephala*, Boiss.
Centaurea solstitialis, L.
—— *virgata*, Lam., var. *squarrosa*.
Mentha tomentosa, Urv.
Marrubium crassidens, Boiss.
Euphorbia cheiradenia, Boiss. & Hoh.
Daphne acuminata, Boiss. & Hoh.

Seir Zoology.—Foxes are said to be common in the valleys near Seir. The only individual which I saw was of a much paler colour than our English species.

* Of the bulbs from Seir which have reached this country alive, *Puschkinia scilloides* is the only one up to the present time which has flowered.

Wolves occasionally visit the villages by night, when they are received like Kurds, with gunshots fired in no particular direction from the roofs of the houses.

Two bats (probably *Rhinolophus hipposideros*, Bechst.) were seen flying about the houses in the evening.

The birds most in evidence were magpies, hoopoes, small insectivorous hawks which nest in great numbers in the higher trees in the city, tits, and numberless sparrows. In the hills a few coveys of the red-legged partridge are to be seen, but they are difficult to approach. Quails frequent the cultivated fields and are taken by hawking, a very popular and fashionable amusement in Persia. Quails are also caught by taking advantage of their stupid curiosity. The fowler and his assistants walk out into the field where the quails are supposed to be and hold up a large white sheet, often decorated with painted snakes, birds of prey, or other unpleasant but conspicuous creatures. The inquisitive quails cautiously walk towards the lure, and finally approach near enough for the patient fowler to put a net over them.

Testudo ibera is common in the dry torrent-beds on the hill-sides. I examined about a couple of dozen and found only three which were free from parasitic Acari, which Mr. A. Michael has kindly identified for me as *Rhipicephalus simus*, or *sanguineus*. The parasites are always attached to parts where they are in no danger of being rubbed off. One tortoise had four of these bloodsuckers, one in the "armpit" of the right hind foot and three on its tail.

Neither lizards nor snakes were as common as I should have expected. *Phrynocephalus* seemed to be unknown to the natives, who, however, described a lizard which seemed to be *Stellio caucasicus*. *Eremia* was fairly abundant.

A list of the insects collected at Seir is given on p. 408. The general character of the Lepidoptera struck me as being remarkably European at first sight; but many of the species exhibit a rather more sandy or desert type of coloration. In the early morning the blues were extremely common on the *Mentha tomentosa* growing near the little stream, ½ mile to the S.W. of the village. Several fell a prey to the voracity of a large black-and-yellow spider (*Lycosa*). The only beetles which I obtained were *Julodis lævicostatus*, L. & G., and *Lixus bardanæ*, F., covered with yellow pollen. The higher slopes of the hills were poor in butterflies during the middle of the day, but rich in

Orthoptera (*Decticus* and *Œdipodidæ*), which, almost invisible when at rest, used to get up in blue clouds before the feet of our horses. Towards evening many wall butterflies come out of their hiding-places under stones and fly about during the short twilight.

Mole-crickets (*Gryllotalpa gryllotalpa*, L.) are common in the moister localities. Ants and ant-lions are to be found up to a height of 6000 feet.

List of Animals distinguished by special names by the Syrians living in the Urmi Basin.

In the compilation of the following list I owe much to my interpreter friends, Shamasha Josip of Superghan and Pepino Sadok or "Popina." The list is confined to those animals with which my informants professed to be personally acquainted, and will enable the reader to form some idea of the state of their zoological knowledge, even though the English equivalents of many of the names are very doubtful. My heartiest thanks are due to Professor Margoliouth and to his talented wife for their help in the revision of the list and in the identification of the languages to which the words belong, whether Old Syriac (O.S.), Neo-Syriac (N.S.), Armenian (Arm.), Arabic (Arab.), Persian (P.), or Turki (T.). (Stoddard) indicates that the word is to be found in his Modern Syriac Vocabulary, of which the manuscript is now in the possession of Professor Margoliouth.

MAMMALIA.

Bat	praka lélé, O.S.; *lit.*="flier by night."
Cat	catou, Arm.
Leopard	nemra, O.S.
Dog	kalba, O.S.
Otter	kalba dmia, O.S. "Water dog."
Wolf	deva, O.S.
Fox	tala, O.S.
„	vachaque, P.
Bear	débba, O.S.
Badger	kouja, N.S. (Stoddard).
Hyæna	hotare. Rare in plain of Urmi, common at Mosul.
Hedgehog	kadouda, koutoulta, koubda. (?=the name of a bird.)
Squirrel	sennara.
Mouse	ukb'ra, O.S. (?=jerboa.)
Water-rat (?)	kora mechk.
Gerbillus or Dipus	kaecha.
„	garoun.
Hare	kirviche, N.S. (Stoddard).
?	qara bache. "Black head," T. (Perhaps the caracal, or desert-lynx *.)

* According to Prof. Blochmann our word *caracal* is derived from the Turki *qara-qolaq*, signifying "black-ear."

Bull	tora, O.S.
Buffalo	kalla, N.S. (Stoddard).
Sheep	vana, O.S. Generally *Ovis steatopygus*.
„ wild	vana dtoura, O.S.
Lamb	péra, O.S., N.S. (Stoddard).
Goat	aza, O.S.
„ mountain	aza dtoura, O.S.
Deer	khzura.
Camel	gamla, O.S.
Hog	surni, O.S.
Horse	sussya, O.S.
Donkey, ass	khmara, O.S.
Mule (Horse ♀ × Ass ♂.)	cavédna, O.S.

Aves.

Eagle	nishra, O.S. =Persian bargut.
Hawk, ? sp.	bashuka, Arab.
Falcon	tocha. =Persian bahri. (See below, bahra.)
„	nessa, O.S.
Falco venaticus	djoudjna, P.
Lanner	baziqa, P.
Sparrow-hawk	baza, Arab. =Persian báshá.
Goshawk	tarlane, N.S. (Stoddard). Used for hawking; =Persian taigun, and tarlán male and female.
Owl	buma, Ar. or O.S.
Goldfinch	sagga, Arab.
Nightingale	andali, Arab.
Thrush	khazel.
Hoopoe	vadvade.
Lark (?)	djidjerta.
Blackbird	shoukrta. *Cf.* shakhroura, O.S.
Fire-crested Wren.	gorguma, P.; azel doukbé, P.
Raven	ourva, O.S.
?	djara.
?	djekha. *Cf.* djakha, below.
Swallow, Swift	snonita, O.S.
Cuckoo	koukou.
Pigeon	kavédare.
Turtle-dove	shoufnina, O.S.
Pheasant (?)	djourda, P.
Partridge	qiqvana, N.S. (Stoddard); qaqbana in O.S.
„	zarkha.
Quail	goupshina, O.S.
?	kheta, déchta. "Hen of the plain."
Stork	laqlaq, Arab.
Flamingo	smouqta, baqlane, O.S.
Pelican	qotan qaqa, O.S.
Gull	qakhouka, NS. (Stoddard).
„ (?)	sevanoga, Arm. =blackbird.
Duck	tona.
„	ourdak, T.
„	jandja.
Goose	gaza, T.
Wild Goose	laqlaq quissé.
Swan?	qiqanousse.

The following Bird names are of uncertain signification:—juka; kourta; dédé, or korkore; sissiarek; djarguna; métlédérou; shagra; djita; maria toré; poupou; bahra; djoulourda; djapdgepa, N.S. (Stoddard) ("flapping wings"); chavere chagane, O.S.; shavere balga, O.S.; souravéle; gatou

margué ("cat of the marsh"); sharvélta, gaza lake; garkha diama; khazel, separmari; jeho; gogtatan; djaroura; alidji; djelkima; kadare; angourte; djakha, P. (sparrow or owl); hogare; vaga, P.; metloue.

Reptilia.

Lizards belonging to various genera: Eumeces, Phrynocephalus, &c.	masousta, N.S. (mésazé in Stoddard).
	jdelourin.
	mgadia goudayé.
	kémkéma.
Snake	khouvé, O.S.
„	khouvé dkanouchta, O.S. "Serpent du ballet," grey, poisonous.
„	api. (?=hyæna.) Said to bleat like a goat.
„	jira mar. Long, thin, crawls very fast.
„	khélda. Very poisonous.
„	soïa. Pointed head, creeps in a straight line.
Tortoise	qaraïa, N.S. (Stoddard).

Amphibia.

Frog	piqqa, paqé, N.S. (Stoddard).

Pisces.

Fish with barbels.	nuna oursa. "Male fish," with moustaches.
Fish without barbels	nuna niqua, O.S. "Female fish," without moustaches.
Silurus glanis	naqe, N.S. (Stoddard). "Whales," occur at Solduz.

Insecta.

Insects	bajouji (or rakhsha), N.S. (Stoddard). From rkhish, to creep.
Caterpillar	terterra, N.S. (Stoddard).
Locust, Cricket, or Grasshopper	kamsa, O.S.
Mole-cricket	qerwâ khmarē (lit.="Ass's scorpion").
Earwig	karsu.
Flea	perta'né, O.S.
Myriopods	madala, O.S.
Fly	didwa, N.S. (Stoddard).

Arachnida.

Spider	zakra gardē, O.S., shikrā dmaiâ.
Scorpion	agerwa, O.S.
Galeodes	harapasse. ="Reptiles" in O.S.

Crustacea.

Crabs, Crayfish	kèdjala.
Woodlouse	'arsha.

Vermes.

Intestinal worms	kurkana, N.S. (Stoddard).
Leech	zalu.
Earthworm or Long worm.	sektéara, O.S., or sikta dar'â. *Lit.*, a pointed stake or ploughshare of the ground in Old Syriac.
Hairy worm	spadita dkhouvé, O.S. Spadita is derived from O.S. word for "pillow."

The Wild Sheep of the Urmi Islands.

By Dr. A. Günther, F.R.S., P.L.S.

(Plate 22.)

A cranium in tolerably good condition with the skin and hairs adhering to the face and forehead, with perfect horns, but without lower jaw, was picked up on Koyun Daghi, the largest island of the Urmi Archipelago. The head is that of an adult ram. There is no other wild sheep (at least not in the very rich collection of the Natural History Museum) to which this head comes nearer, as regards size of cranium and form of the horns, than the Cyprian Mouflon (*Ovis ophion*). Yet there is a striking difference in the sweep and direction of the horns; but without further information it would seem to me premature to introduce this sheep as a distinct species. It certainly must appear very singular that a sheep from a lacustrine island of Western Persia should be more nearly allied to the distant and local form from Cyprus, than to the typical *Ovis orientalis* which is reported from the Elburz and Armenian mountains * and other parts of Asia Minor.

Ovis ophion, var. urmiana.

I have no materials to demonstrate any craniological characters by which this form may differ from either *O. orientalis* or *O. ophion*, but the size of the skull (and by inference of the whole animal) may be conceived from the following measurements:—

	millim.
Distance between end of intermaxillary and upper rim of occipital foramen	230
Distance between end of intermaxillary and palatal notch	120
Length of molar series	65 and 69
Distance between the two series in front	15
„ „ „ behind	50
Distance between lower rims of orbits	125
„ „ styloid processes	63
Greatest width of occipital condyles	57

* W. T. Blanford, 'Eastern Persia,' ii. p. 88; Danford & Alston, Proc. Zool. Soc. 1880, p. 55.


b
a
b

The horns are bent outwards in a regular curve, describing a semicircle, without any trace of that spiral twist at the extremity which seems to be constant in the adult Cyprian Mouflon; in fact the whole of their posterior surface, which is broad and flat (or partly concave), lies in the same plane; and the horns are so little turned backwards, that this plane would make an angle of about 70° with a plane vertically bisecting the cranium. The horns measure round the outer curve 500, round the inner 305 millim., their circumference round the base being 190 millim. and the distance from tip to tip 360 millim. They are remarkably flattened and compressed in a vertical direction, with an obtuse upper and a sharp lower ridge; a fronto-orbital ridge, which I observe to be still very distinct in *O. gmelini* and *O. cycloceros*, has nearly disappeared on the left horn, and is very obtuse near the base of the right horn. A transverse section through the left horn about two inches from the base would represent one half of an irregular oval (fig. *a* on Plate 22), and one about the middle of the horn would be still more compressed (fig. *b*). The end of the horn is almost knife-shaped. The transverse wrinkles are blunt, coarse, and rather distant. Besides these transverse wrinkles, there are at irregular intervals five deep grooves penetrating through the substance of the horn, and dividing each horn into six sections of unequal length. These grooves are, as regards position, perfectly symmetrical on both sides, and evidently indicate periods of growth (probably annual); and if this be the case, the skull would be that of an animal six or seven years of age. The terminal (oldest) section measures (along the middle) 70 mm., the next 70 mm., the third 40 mm., the fourth 115 mm., the fifth 75 mm., the sixth (during which the animal was killed) 33 mm. Abundance or scarcity of food, or other physiological causes, may account for the want of regularity in the growth of the horn.

No trace of the fronto-orbital ridges is visible on the bony core, a transverse section of which represents one half of a regular oval.

The colour of the hair attached to the head is now a uniform light isabelline, but no importance can be attached to this, as the colour may have been bleached by exposure; the horns are also similarly bleached, traces of the normal dark colour being still visible in some parts.

If the specific limits of the Asiatic Mouflon (*Ovis orientalis* s. *gmelini*) be so far extended as to include the Cyprian Mouflon *, our sheep should be named *Ovis orientalis*, var. *urmiana*; but in the present very fragmentary state of our knowledge of the wild sheep of Western Asia, I think it best to associate it with the Cyprian Mouflon, to which it seems to be more closely allied than to any of the other forms from Asia Minor.

The Pliocene Mammalia of the Bone-beds of Maragha.

By Robert T. Günther, M.A.

On arriving at Maragha my first enquiries were about the fossil bones found in the neighbourhood. I stayed at the house of Quasha Mushi, a Christian preacher, who informed me that he had already excavated and despatched 14 loads of Mammalian bones and two boxes of other stones (? Jurassic fossils) to Dr. Pohlig at Vienna. He also told me that his palæontological researches had been stopped by a suspicious government who believed that all digging was for hidden treasure, and therefore was an illicit interference with the rights of the mineral monopolists.

On Sept. 5th I started soon after sunrise on a three-hours' ride to Kirjawa, the village nearest the bone-beds. The road from Maragha crossed a succession of gravelly hills largely composed of pebbles of andesites of varying basicity, from hornblende-andesite to basalt, which shortly before Kirjawa are succeeded by hills of pumiceous tufa. Mr. Prior, who has been kind enough to examine my specimens, assures me that this volcanic deposit is remarkably similar to the tufa of the bone-beds at Samos of similar age.

During the day the villagers and myself were able to pick up the bones in the following list. In their identification I have been greatly helped by the experience of Dr. C. I. Forsyth Major, who has recently studied the contemporaneous fauna of Samos. I am glad to take this opportunity of thanking him for the kind way in which he interrupted his other researches to help on mine. The species in *italics* have been described from Maragha by other palæontologists †.

* A view taken by Lydekker in 'Wild Oxen, Sheep, and Goats.'

† *Cf.* Forsyth Major, 'Le Gisement ossifère de Mitylini.' Lausanne, 1894.

MAMMALIA.

CARNIVORA.

Hyæna evimia, Roth. et Wagn.
Ictitherium hipparionum, Gaudr.
Meles maraghanus, Kittl.

ARTIODACTYLA.

Fam. ANTILOPIDÆ.

Gazella deperdita, Gaudr.
Gazella brevicornis. Horn-core.
Prostrepsiceros (?) sp.
Tragoceros amalthæus, Gaudr. Upper left m^1, m^2.
Palæoreas lindermayeri, Gaudr.
Antilope sp. Right upper molar. Metacarpal about 1 ft. 2 in. in length.
Palæoryx pallasii, Gaudr.
Protoryx longiceps, Maj.
Protoryx gaudryi, Maj.
Helicophora rotundicornis, Weith.

Fam. OVIDÆ.

Criotherium argalioides, Maj. Left upper m^3.

Fam. GIRAFFIDÆ.

Samotherium boissieri, Maj. 2 calcanea.

Fam. SUIDÆ.

Sus erymanthius, Roth. et Wagn Right upper molar.

PERISSODACTYLA.

Fam. EQUIDÆ.

Hipparion mediterraneum, Hensel. 14 upper molars and premolars; 5 lower molars and premolars; 1 incisor; right and left astragali; fragment of splint bone.

RHINOCEROTIDA.

Rhinoceros sp., probably blanfordi, Lyd. Fragments of teeth and of lower jaw; patella.

PROBOSCIDEA.

Fam. ELEPHANTIDÆ.

Mastodon pentelici, Gaudr. et Lart. Molar.
Mastodon sp. Tusk.

EDENTATA.

Orycteropus gaudryi, Maj.

It will thus be seen that the presence of *Tragoceros amalthæus*, Gaudr., at Maragha is confirmed, and that the known fauna has been enriched by the discovery of a sheep which Dr. Major considers identical with his *Criotherium argalioides* from Samos, and of which there is an exceedingly fine skull in the British Museum. The presence of *Gazella brevicornis* is also indicated.

The bones are well preserved in a deposit of light brown pumiceous tufa, stratified in horizontal beds of unequal hardness, but they are difficult to get out entire without fracture. The village people regard the Mastodon bones as the remains of the big men who lived before the flood; but the chief man of the village classified the bones under the heads elephant, deer, swine, unicorn, and "dēvy," or men with horns like genii.

REPTILIA AND AMPHIBIA.

By G. A. Boulenger, F.R.S., F.Z.S.

LACERTILIA.

1. Phrynocephalus helioscopus, *Pall.*

Khoi: 1 specimen. North of Lake Urmi: 2 specimens.

These specimens agree with the Persian variety described by De Filippi and by Blanford under the name of *P. persicus*, having a pair of pink spots, edged with blue, on the nape. One of the specimens from L. Urmi differs, however, from Blanford's description of *P. persicus* in having the larger scales along the spine bluntly but very distinctly keeled. The large series preserved in the British Museum removes all doubts as to the specific identity of *P. persicus* with *P. helioscopus*. The bright nuchal markings are often present in Central-Asian examples.

An excellent description of the coloration from living specimens has been given by L. v. Méhely, Zool. Anz. 1894, p. 82; but I can see no sufficient ground for the establishment of his var. *Horvathi*.

2. Lacerta viridis, *Laur.*

Bash Nurashin, Sept. 23.

A young specimen of the var. *strigata*, Eichw.: uniform dark olive-brown above, with five yellowish-white longitudinal lines. Ventrals in 6 longitudinal series; 38 scales across the body; 17 pores under each thigh.

3. Ophiops elegans, *Ménétr.*

Numerous specimens of the typical form, all with two superposed postnasals. Considering the wide range of variation of the numbers of scales and femoral pores, it may be of interest to record the figures occurring on the specimens collected by Mr. Günther. Under A is given the number of scales round the

middle of the body, ventrals included; under B the number of femoral pores on both sides.

	A.	B.
Arzu Island, ♂	33	9–9
„ „ ♀	31	8–9
„ „ yg.	32	9–8
„ „ „	32	8–9
Shazalan Island, ♂	33	8–8
Sujbulak, ♂	34	11–12
St. George's Hill, Superghan ♂	31	10–10
„ „ ♀	31	11–10
„ „ ♀	35	10–10
Between Superghan and Urmi, ♂	33	8–8
Seir, ♂	33	10–11
„ ♂	32	10–10
„ ♂	32	12–12
„ ♀	30	9–9
„ ♀	31	10–11
„ yg.	32	10–11
„ yg.	34	10–10
Kirjawa, ♀	30	9–9
„ yg.	34	10–10
„ yg.	32	10–10

4. Mabuia septemtæniata, *Reuss.*

A single half-grown specimen from Koyun Daghi.

34 scales round the body, dorsals indistinctly tricarinate. As in one of the Persian specimens in the British Museum (Teheran), the four black dorsal stripes of the typical form are present on the nape, whilst on the back they are broken up into spots.

5. Eumeces Schneideri, *Daud.*

Two specimens from Koyun Daghi agree entirely with the typical, widely distributed form, as figured by Anderson in his 'Reptiles of Egypt,' pl. xxv. Greyish olive above, with small orange spots and an orange lateral streak. 28 scales round the middle of the body. The distance between the end of the snout and the fore limb is contained once and four-fifths in the distance between axilla and groin.

A remarkably large specimen from Vizastra (17 centimetres from snout to vent) is brownish above, without orange spots, but with a darker dorsal stripe occupying the two median rows of scales, and a still darker stripe, two scales wide, on each side above a yellow lateral streak which extends from the mouth, through the ear, to the hind limb. The body is more elongate, the distance between end of snout and fore limb being contained twice in the distance between axilla and groin; and there are but 24 scales round the body. This lizard approaches the form figured by Geoffroy in the 'Description de l'Égypte,' Rept. pl. iii. fig. 3, of which we have a specimen from Jerusalem in the British Museum, and agrees with specimens from Cyprus (*Scincus cyprius*, Cuv.), Transcaspia, and Persia.

A young specimen from Shazalan Island (73 millim. from snout to vent) agrees in the proportions and the number of scales (28 round the body) with the Koyun Daghi examples, but the back is marked with four blackish stripes, in addition to which every other scale in every longitudinal series bears a central yellowish spot. This system of coloration is closely approached by that of a young specimen from Jerusalem in the British Museum, which differs only in having a blackish line bordering the belly below the yellow lateral stripe.

A study of the juvenile livery of this species would be a great help towards the establishment of geographical varieties; but it is a most curious, and to me unaccountable fact, that young specimens of the common Palæarctic *Eumeces* are extremely rare in collections. I have only seen three of *E. Schneideri* and not one of *E. algeriensis*.

OPHIDIA.

6. Eryx jaculus, *L.*

A single specimen from Seir, near Urmi. It agrees in every respect with the typical or Western form, the habitat of which is known to extend from Greece and the Ionian Islands to Lower Egypt and Persia; the Eastern form, var. *miliaris*, with smaller head-shields, inhabiting Transcaspia, Turkestan, and Afghanistan. The Urmi specimen has 5 scales between the eyes, 3 between posterior nasal and eye, 9 round the eye, and 9 upper labials on each side. 48 scales across the thickest part of the body. Ventrals 186; subcaudals 18.

7. Tropidonotus tessellatus, *Laur.*

Eastern shore of L. Urmi, Seir, Maragha. Four specimens.

This is a common and widely-distributed snake; but one of the specimens is of interest in having the upper labials almost excluded from the eye by the suboculars, merely the point of the fourth labial penetrating between the latter. Specimens of this species may probably turn up some day with the labials entirely excluded from the eye, as in *Tropidonotus ferox*, *anoscopus*, and *cyclopium*.

BATRACHIA.

8. Rana esculenta, *L.*

Several specimens, half-grown, young, and larvæ, belonging to the var. *ridibunda*, Pall. Ocksa, Superghan, Maragha, Kirjawa.

9. Rana Camerani, *Blgr.*

Banda, Urmi River. Two young specimens.

10. Bufo viridis, *Laur.*

A young specimen from Sujbulak and several tadpoles from the town-ditch at Urmi.

11. Hyla arborea, *L.*

Several specimens, half-grown, young, and larvæ, belonging to the var. *Savignyi*, Aud. Bash Nurashin, Urmi town, Banda, Superghan; also a young specimen from Lake Urmi, "in salt water."

The tadpoles have the black lines on the muscular part of the tail to which attention has been drawn by Camerano.

12. Pelobates fuscus, *Laur.*

Three large tadpoles from Superghan, one with well-developed limbs. This species was known to occur at Lenkoran on the Caspian, but had not yet been recorded from Persia.

FISHES.

By Dr. A. Günther, F.R.S., P.L.S.

(Plates 23 & 24.)

The general character of the Freshwater-fish Fauna of Western Asia, as a part of the Europæo-Asiatic region, is well known through the researches of Russell, Heckel, de Filippi, Keyserling, Kessler, Radde, Lortet, Sauvage, and myself*; and in this respect the small collection from the Urmi basin does not contribute any additional facts of great novelty. On the other hand, our acquaintance with the local faunas of the various districts of Western Asia is more or less fragmentary, and a comparative study of the several species of which they are composed is a great desideratum. Of the Fish-fauna of the Urmi district we had no positive knowledge whatever; and the materials available at present for a useful direct comparison of the species inhabiting the rivers which take their rise in the Kurdistan and Armenian mountains, viz., the Tigris, Euphrates, Kur, Araxes, and the Lake Van and Urmi rivers, are extremely scanty and insufficient for the purpose.

* Consult more especially H. E. Sauvage, "Notice sur la Faune ichthyologique de l'Ouest de l'Asie," Nouv. Arch. Mus. vii. 1884.

In the consideration of the Urmi fauna we have to bear in mind that the rivers of this basin do not communicate with the sea, and, consequently, that migratory fishes are absent: like the Jordan, they are not inhabited by shad, eel, sturgeon, or lamprey. Neither is there direct communication between the rivers themselves in spite of the close proximity of their mouths, the water of the lake being of such concentrated salinity as to prevent the passage of fish from one river into another. Such an isolation of the inhabitants of the several rivers must have been a favourable factor for the development of differential specific characters. The great severity of the climate in winter will account for the absence of warmth-loving types such as *Cyprinodon*.

If we are permitted to draw conclusions from so small a collection, we may say that the fauna bears distinctly the character of that of Central Europe, so far as the genera are concerned (with the addition of *Capoëta*); and although the majority of the species seem to be sufficiently differentiated local representatives, two of them, namely, the Silurus and Chub, are identical with the European forms. Probably further investigations may reveal the presence of certain other fishes, such as stickleback, trout, *Rhodeus*, which Mr. Günther has not been able to find; but the fish-fauna as a whole is certain to prove to be poor in species, much poorer than that of the Kur and Araxes, to which, however, it is most closely allied, as is evidenced by the identity (real or supposed) of five out of the ten species enumerated below.

The specimens were collected,—

1. In the Tatawa Chai near Sujbulak, entering the south end of the Lake.

2. In the Gader Chai near Ocksa, likewise at the southern end of the Lake.

3. In the Urmi River (Shaher Chai).

4. In the Nazlu Chai, entering the north-western part of the Lake, at Superghan near the mouth, and at Tergawar in its upper courses.

5. In the Zola Chai, near Ula.

Silurus glanis, *L.*

It might have been supposed that the *Silurus* of Western Persia would prove to be identical with the form which Sauvage *

* Bull. Soc. Philom. 1882, p. 163; Nouv. Arch. Mus. 1884, vii. p. 19, pl. fig. 1.

has described from the River Kur under the name of *Silurus chantrei*. But this supposition is not borne out by a specimen obtained in the Gader Chai at Ocksa. It is the skin of an adult individual much cut about and without pectoral fins. However, the number of anal rays can be ascertained to be 84, thus nearly approaching in this respect our European *S. glanis*, whilst 65 is the number given for *S. chantrei*. Also in other respects, especially with regard to the composition of the dorsal fin and the length of the barbels, it proves to be a typical *S. glanis*. I have some doubts as to whether *S. triostegus* of Heckel, from the Tigris, can be maintained as a distinct species. The dorsal fin of *Silurus* is a rudimentary organ, and therefore may be expected to vary in the number and development of its rays. Even in European specimens the fourth dorsal ray is not constantly branched, but may be simple and reduced in size, and I have found it so also in a specimen from the Tigris. However, the barbels of Mesopotamian specimens seem to be shorter than in European.

CAPOËTA GRACILIS.

Scaphiodon gracilis, Keyserling, Zeitschr. ges. Naturw. xvii. 1861, p. 9, tab. 4.

Scaphiodon sieboldii, Steindachner, Verh. zool.-bot. Ges. Wien, 1864, p. 224.

? *Capoëta sevangi*, De Filippi, Viaggio in Persia, p. 312 (1865).

Capoëta gracilis, Günther, Fish. vii. p. 80 (1868).

D. 3/8. A. 3/5. L. lat. 53–55. L. transv. $8\frac{1}{2}$/6–7.

The height of the body is one fourth or two ninths, the length of the head two ninths of the total length (without caudal); the diameter of the eye is one fifth of the length of the head and contained $1\frac{2}{3}$ in the length of the snout, and $2\frac{1}{4}$ in the width of the interorbital space. Barbels rather shorter than the eye. Origin of the dorsal fin midway between the end of the snout and the root of the caudal; distance between the first dorsal ray and occiput rather less than that between the last dorsal ray and root of the caudal. Least depth of the caudal peduncle about one half of the length of the head. Third dorsal ray feeble, soft in its terminal portion, and distinctly serrated, the serrature being hidden below the skin. Pectoral rather shorter than the head, not extending to the ventral. Caudal deeply emarginate. Scales in the anal region not distinctly enlarged. Coloration uniform.

This fish was originally described from the neighbourhood of Ispahan, and, if my identifications are correct, at later periods from Amasia (Asia Minor) by Steindachner, and from Lake Gokcha by De Filippi. Thus it seems to have a considerable range in Western Asia, and the present collection contains specimens from Sujbulak, from the Urmi River, and the Nazlu Chai. The largest specimen is 213 millim. long. The species is subject to a considerable amount of variation, not merely dependent on local influences, but apparently quite individual, as it obtains in specimens captured at the same spot and at the same time. In specimens from Sujbulak the cleft of the mouth is quite straight, extending the whole width from side to side, the dorsal spine is very feeble, and the crown of the head flattened. In a specimen from the Urmi River the crown of the head is more convex, the dorsal spine sensibly stronger, the mouth gently crescent-shaped, and there are only six longitudinal series of scales between lateral line and ventral fin. The form of the mouth varies in three specimens from Superghan (Nazlu Chai), from straight to a gentle crescent, and to a distinct crescent; the strength of the dorsal spine is intermediate between the Sujbulak and Urmi specimens, and the longitudinal rows of scales between lateral line and ventral fin varies from six to seven; they have altogether the appearance of being less well-fed than the specimens from Sujbulak. Two specimens from Ula represent a dwarf form with very feeble and indistinctly serrated dorsal spine; the larger, a male, is only 125 millim. long, yet fully mature, with developed testicles and with a seasonal growth of minute tubercles along the whole side of the body.

These fishes, for which I have adopted Keyserling's name, belong to a group of the genus which is distinguished by the feeble development of the dorsal spine and by scales of moderate size. The fishes of this group show a considerable amount of modification of the characters of various organs, such as I have pointed out in the specimens from the Urmi district. Consequently they have been described under numerous specific names; but without long series of specimens with exact localities, it is impossible to form an opinion as to which of these names deserve recognition.

Thus, *Capoëta steindachneri*, Kessler (Izvest. obshchest. Lynbit. estestv. x., Mosc. 1872, p. 47, pl. 6. figs. 3–5, or Fedschenko, Fauna of Turkestan, Pisces, St. Petersb. 1874, p. 7, pl. 1. figs. 3 & 4),

seems to be distinguished (if we judge from the figure) from our *C. gracilis* by a greater number of scale-rows between lateral line and ventral fin. It is said to have *one or two* pairs of barbels. The specimens were from the River Sarefschan.

Filippi's description of his *Capoëta sevangi* from Lake Gokcha contains nothing by which we could distinguish this fish from *C. gracilis*. But the fish described and figured under the name of *C. sevangi* by Kessler * is certainly distinct from our *C. gracilis*. As, according to Kessler's investigations †, Lake Gokcha is inhabited by several species of *Capoëta*, we are left in uncertainty as to whether the fishes named *sevangi* by Filippi and Kessler are specifically the same.

Scaphiodon sieboldii, Steindachner, is described from a specimen 133 millim. long. The eye is noted as of somewhat larger size than in our specimens, but the comparative size of this organ is subject to the usual changes with the growth of the individual.

Barbus caucasicus.

? *Barbus caucasicus*, Kessler, Aralo-Caspio-Pontine Ichthyol., in Grimm, Aralo-Casp. Exped. p. 102.

D. 10. A. 8. L. lat. 90 ‡. L. transv. 13–14/18–20.

The height of the body is contained $5\frac{1}{2}$ or $5\frac{2}{3}$ times in the total length (without caudal), the length of the head $4\frac{1}{4}$ or $4\frac{3}{4}$ times. The diameter of the eye is one half of the length of the snout and two elevenths of that of the head; interorbital space not quite twice as wide as the eye. Anterior barbels a little shorter than posterior, which are not twice as long as the eye. Caudal peduncle longer than deep. Dorsal spine rather feeble, but finely serrated behind, somewhat nearer to the root of the caudal than to the end of the snout, opposite to the root of the ventral. Anal fin not reaching to the caudal. Caudal slightly emarginate, but in young examples (of 110 millim.) the excision is deeper. Pectoral shorter than the head, rounded. Eleven longitudinal

* "Fish of the Aralo-Caspio-Pontine region," in Suppl. Trans. St. Petersb. Nat. Hist. Soc. 1877, p. 81, fig. 18.

† *L. c.*; Sauvage, Nouv. Arch. Mus. vi. 1884, pp. 5, 22. In the figure of *C. gotschaica* (pl. 3. fig. 3) the scales are represented much larger than in the description.

‡ 90, counting the transverse series above the lateral line; the perforated scales of the lateral line are somewhat larger and irregular, and about 80 in number.

series of scales between the lateral line and ventral fin; pharyngeal teeth 5 | 3 | 1. Sides of the body, dorsal and caudal fins speckled with greyish.

Three small specimens were obtained in the Zola Chai at Ula, and a larger one in Tergawar, in the upper waters of the Nazlu Chai. The latter is 153 millim. long, and presumably young. It shows some larger scales on each side of the vent, and therefore the question arises whether our fishes are the young stage of a species of *Schizothorax*. I have no materials which would assist me in ascertaining whether the peculiar anal sheath of *Schizothorax* is developed with age. The two genera, *Barbus* and *Schizothorax*, are so closely allied that in all probability species exist in which the initial stages of the development of an anal sheath may be traced either as a distinctive specific character or as an individual, more or less abnormal condition.

The determination of these Persian specimens as *Barbus caucasicus* is not by any means satisfactory. I should not have recognized them from Kessler's description, who gives as scale-formula 60, $\frac{11-12}{8-9}$, 65, indicating a fish with scales considerably larger; but the Natural History Museum has received from Russian sources, two larger specimens named *B. caucasicus*. These specimens approach the Persian closely enough to be referred to the same species. That collection possesses also specimens of *Barbus ciscaucasicus* and *Barbus goktschaicus*, two other species described by Kessler in the work quoted. These also are most closely allied to *B. caucasicus*, but *B. goktschaicus* has the dorsal spine extremely feeble. I have finally to add that neither of the two specimens of *B. caucasicus* in the Natural History Museum has enlarged anal scales, and that in one of them the anal fin reaches to the caudal, when laid backwards.

Our fishes differ from *Barbus miliaris* (de Filippi, Viaggio, p. 358), from Teheran, in having only 13 or 14 series of scales between the dorsal fin and lateral line, the Teheran species having 18.

Gobio persa, sp. n. (Pl. 23. fig. B.)

D. 10. A. 8. L. lat. 43. L. transv. 6/9.

The height of the body is contained $5\frac{1}{2}$ times in the total length (without caudal), the length of the head 4 times; caudal peduncle slender, but slightly compressed, its greatest depth being two fifths of its length. Snout not greatly elongate, the diameter of

the eye being two thirds of its length and one fourth of the length of the head; *interorbital space broad* and flat, its width being a little more than the diameter of the eye. Upper jaw overlapping, but not much projecting beyond the lower; maxillary barbel reaching to the hind margin of the eye. Dorsal fin with seven, anal with six branched rays; pectoral reaching the ventral, ventral the anal. Caudal moderately excised, with pointed lobes. Five series of scales between lateral line and ventral fin. Back and sides irregularly speckled with black; a series of from seven to nine larger ovate spots along the lateral line. Dorsal and caudal rays speckled with black.

Seven specimens, 70 millim. long, from Ocksa in the Gader Chai.

This form of Gudgeon comes nearest to *G. uranoscopus*, having a slender peduncle of the tail, but slightly compressed; and compared with specimens of the same size, it shows a distinctly shorter snout and a greater width of the interorbital space. I have not the means of comparing it with *Gobio kessleri* from the Dniester, which, however, is described as possessing eight branched dorsal rays.

Leuciscus cephalus, *L.*

The Chub is one of the most common fishes in the rivers falling into Lake Urmi. Specimens of small and moderate size were obtained at Sujbulak, in the Gader Chai and Urmi Rivers, and in the Nazlu Chai. I consider them specifically identical with the European Chub; their head is equally broad, but rather more elongate or depressed than is usually observed in British specimens. But Continental specimens frequently show the same degree of elongation and the same form as the Persian fishes.

The short description given by de Filippi of his *Squalius turcicus* (Viagg. Pers. p. 359), from Erzeroum, applies very well to these Persian specimens.

Leuciscus ulanus, sp. n. (Pl. 24. fig. A.)

D. 10–11. A. 13. L. lat. 44. L. transv. 8/5.

The height of the body is contained from $3\frac{1}{2}$ to $4\frac{1}{4}$ times in the total length (without caudal), the length of the head 4 or $4\frac{1}{4}$ times. The diameter of the eye is one fourth of the length of the head and a little less than the width of the interorbital space, which is transversely convex. Snout obtuse, as long as the eye; upper

jaw slightly overlapping the lower; cleft of the mouth oblique, the maxillary not quite reaching the vertical from the front margin of the orbit. Nape of the neck but little raised above the level of the head. Extremities of the fins obtusely rounded off. The origin of the dorsal fin is nearer to the root of the caudal than to the end of the snout, and behind the vertical from the root of the ventral; it is higher than long. *Anal fin rather lower than long.* Caudal excision moderate. Pectoral shorter than the head, not reaching the ventral. Caudal peduncle nearly or not quite twice as long as deep. There are three series of scales between the lateral line and ventral fin. Back bluish, sides silvery, both colours separated by a narrow straight black band running from the upper half of the eye to the end of the lateral line. Pharyngeal teeth 5.2–2.5.

Two specimens, 105 and 83 millim. long, from Ula on the Zola Chai.

Leuciscus gaderanus, sp. n. (Pl. 24. fig. B.)

D. 11. A. 12. L. lat. 40. L. transv. $6\frac{1}{2}/4$.

The height of the body equals the length of the head and is one fourth of the total (without caudal). Diameter of the eye one fourth of the length of the head and a little less than the width of the interorbital space, which is transversely convex. Snout obtuse, as long as the eye; upper jaw slightly overlapping the lower; cleft of the mouth oblique, the maxillary not reaching the vertical from the front margin of the orbit. Nape of the neck but little raised above the level of the head. The origin of the dorsal fin is nearer to the root of the caudal than to the end of the snout, and behind the vertical from the root of the ventral; it is higher than long. *Anal fin a little higher than long.* Caudal excision moderate, lobes pointed. Pectoral shorter than the head, not reaching the ventral. Caudal peduncle twice as long as deep. There are two and a half series of scales between the lateral line and ventral fin. Back bluish, sides silvery, dotted with numerous minute pigment-spots; a narrow straight blackish band runs from the upper end of the gill-opening to the end of the lateral line. Pharyngeal teeth 5.2–2.5.

Three specimens, the largest 90 millim. long, from the Gader Chai; three young specimens from near the mouth of the Nazlu Chai at Superghan.

The propriety of distinguishing this form from *L. ulanus* under

a separate name may be questioned. However, the larger size of the scales is so striking a feature, that, without having intermediate forms, I think it better to keep the two forms distinct. *Telestes leucoides*, Filippi, Viagg. Pers. p. 359, from the Batoum River, seems to be also a closely allied species, but is described as agreeing in form with *L. aula*, which is a fish with a much higher body.

Abramis urmianus, sp. n. (Pl. 23. fig. A.)

D. 11. A. 14–16 *. L. lat. 58–62. L. transv. 12/8.

The height of the body is two sevenths, the length of the head one fourth of the total (without caudal). Snout neither pointed nor obtuse, equal to the diameter of the eye, which is one fourth of the length of the head; interorbital space transversely convex, scarcely wider than the orbit. Cleft of the mouth slightly oblique, with the jaws equal in front, the maxillary not extending to the vertical from the front margin of the eye. Abdomen rounded in front, and compressed behind, the ventrals. Caudal peduncle longer than deep. Pectorals not reaching the ventral, shorter than the head. Origin of the dorsal midway between the end of the snout and the root of the caudal. Caudal excision moderate. Five series of scales between the lateral line and ventral fin. Pharyngeal teeth 5/2, hooked. Silvery, greenish-olive on the back; sides with numerous minute brownish pigment-spots; they are more crowded above the lateral line, producing an inconspicuous darker band along the whole length of the side.

Five specimens from the Gader Chai and two small ones from the Urmi River; the largest is only 144 millim. long, but specimens of this size are mature, showing not only fully developed sexual organs, but also some of those deep-black spots which appear in so many Cyprinoids during the breeding-season. The gill-rakers are very short, triangular in shape, and widely set, as is characteristic of the genus *Abramis*, in opposition to *Alburnus*.

This species resembles *Alburnus punctulatus*, Kessler (Aralo-Caucas.-Pont. Ichthyol. p. 159), but has a shorter and smaller anal fin, whilst in the former species this fin is composed of 17

* 14 in two, 15 in five, 16 in one specimen; the first three rays being simple in all.

to 20 rays. The gill-rakers of *A. punctulatus* are very short; and therefore this species should be referred to *Abramis*. A specimen from Tiflis is in the Natural History Museum.

ALBURNUS FILIPPII.

Alburnus filippii, Kessler, in Grimm's Aralo-Caspian Exped., Pisces, 1877, p. 153.

D. 11. A. 13–14 *. L. lat. (54) 56–60. L. transv. (9) 10/6.

The height of the body is contained $4\frac{2}{3}$ times in the total length (without caudal), the length of the head $4\frac{1}{3}$ times. Snout rather pointed, equal to the diameter of the eye, which is scarcely one fourth of the length of the head. Interorbital space transversely slightly convex, scarcely wider than the orbit. Cleft of the mouth oblique, with the lower jaw slightly the longer, the maxillary not extending to the vertical from the front margin of the eye. Abdomen rounded in front, slightly compressed behind, the ventrals. Caudal peduncle at least twice as long as deep. Pectorals not reaching the ventral, shorter than the head. Origin of the dorsal nearer to the root of the caudal than to the end of the snout. Caudal excision moderate. Four series of scales between the lateral line and ventral fin. Pharyngeal teeth † 4/2, hooked. Silvery, olive on the back; a narrow, straight, well-defined blackish band from the upper end of the gill-opening to the middle of the caudal fin.

Three specimens from Sujbulak, the largest 113 millim. long; one specimen from Superghan near the mouth of the Nazlu Chai.

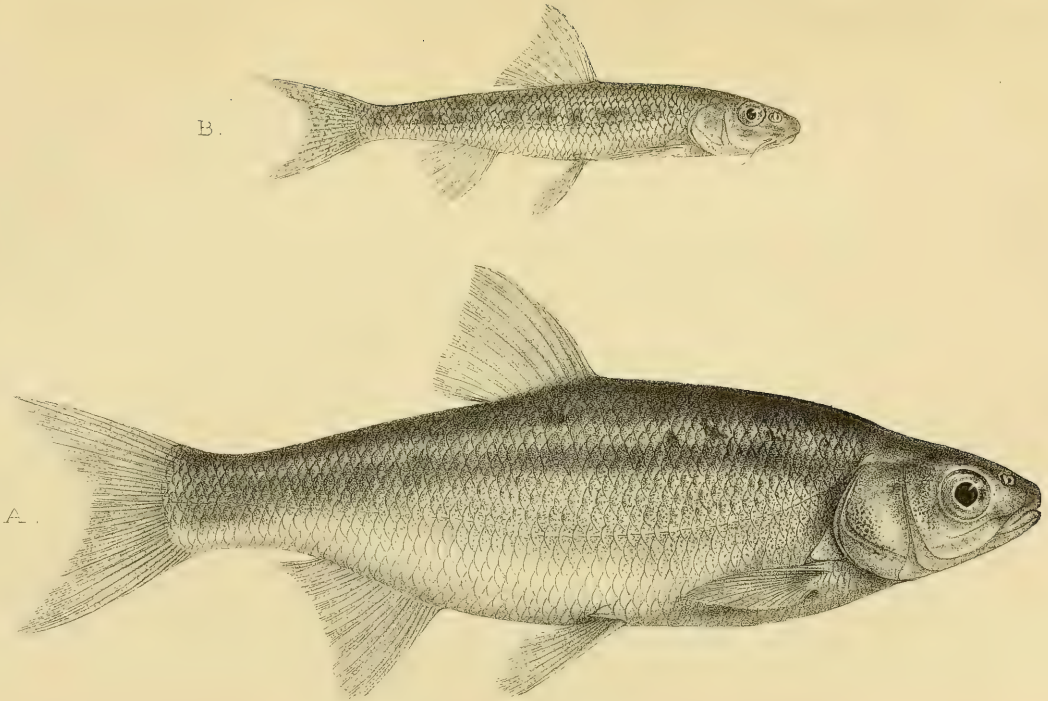
The gill-rakers are lanceolate, closely set, but the longest scarcely half as long as the eye.

The specimen from the Nazlu Chai differs slightly from the others, inasmuch as the scales are apparently a little larger; I count only 54 in the lateral line, and 9 in the transverse series between dorsal fin and lateral line.

Kessler states that his specimens were obtained from the Kur at Tiflis and at Borjom; in the fin-formula the number of dorsal rays is stated to be 1/6–7, which would be so abnormal in this genus that I suspect it to be due to some inadvertence.

* 13 in one, 14 in three specimens, the three anterior rays being simple.

† Examined in one specimen only.

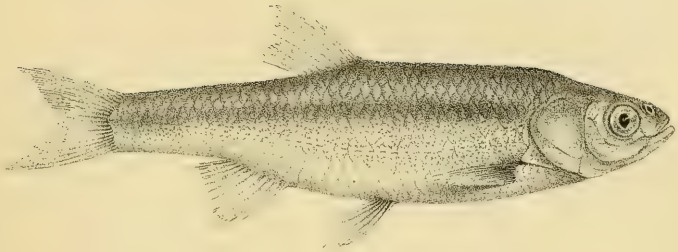


J. Green del. et lith.

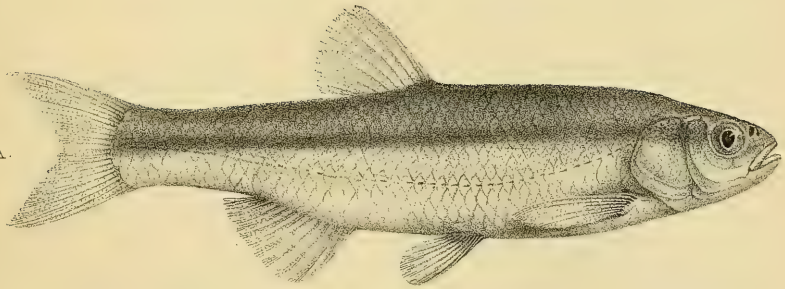
A. ABRAMIS URMIANUS. B. GOBIO PERSA.

Mintern Bros. imp.

B.



A.



J. Green del. et lith. Mintern Bros. imp.

A. LEUCISCUS ULANUS. B. LEUCISCUS GADERANUS.

NEMACHILUS PERSA.

Cobitis persa, Heckel, in Russegger's Reis. ii. 3. p. 266; de Filippi, Viaggio, p. 360.

Nemachilus persa, Günth. Fish. vii. p. 347.

D. 11. A. 7. P. 10. V. 7.

Scales minute, but conspicuous. Caudal fin distinctly emarginate. Origin of the dorsal fin nearer to the root of the caudal than to the end of the snout. The height of the body is less than the length of the head, which is contained $4\frac{1}{4}$ times in the total (without caudal). Head rather narrow; snout somewhat pointed, nearly as long as the postorbital portion of the head; eye small. Pectoral as long as the head, its length being two thirds of the distance between its base and that of the ventral. Caudal peduncle nearly twice as long as deep. Whitish, densely reticulated and speckled with greyish. Dorsal and caudal fins speckled with greyish.

Four specimens, 65 millim. long, from the Zola Chai; others from the Elinja Chai, a tributary of the Araxes.

The specimens on which this species was founded were obtained at Persepolis; de Filippi found it generally distributed in abundance in all Persian rivulets.

EXPLANATION OF PLATES 23 & 24.

Pl. 23. Fig. A. *Abramis urmianus*, sp. n.
Fig. B. *Gobio persa*, sp. n.
Pl. 24. Fig. A. *Leuciscus ulanus*, sp. n.
Fig. B. *Leuciscus gaderanus*, sp. n.

LAND AND FRESHWATER MOLLUSCA.

By EDGAR SMITH, F.Z.S.

1. HELIX (HELICOGENA) FIGULINA (*Parreyss*).
Hab. Seir.

2. HELICELLA ACUTISTRIA (*Böttger*).
Hab. Koyun Daghi.

3. HELICELLA PARABLETA (*Böttger*).
Hab. Urmi district (?).

4. Helicella, n. sp.

Hab. Seir.

A single specimen only, with the peristome immature. Prof. Dr. O. Böttger very kindly examined this and several other species enumerated in this list, and considers it a new species "aus der Gruppe *apicina*, Lmk." He also observes, "Aehnliche Arten sind meines Wissens aus Asien noch nicht beschrieben." It has very much the form of the preceding species, but with the spire less elevated. It is white, prettily marked with about eight interrupted spotted brown spiral lines, whereof three are above the obtusely-keeled periphery, the rest and a few intervening series of minute dots being on the lower surface. Some of the brown spots are punctate, especially the row just above the peripheral keel. The two nuclear whorls are light corneous and smooth, the remaining three volutions being marked with strong, very oblique, incised lines of growth.

5. Helicella pisiformis (*Pfeiffer*).

Hab. Seir.

6. Buliminus (Zebrinus) Hohenackeri (*Krynicki*).

Hab. Ula, Plain of Salmas.

7. Buliminus (Chondrulus) tridens (*Müller*).

Hab. Ula?, Plain of Salmas.

These specimens belong to the var. *major*, Kryn. (=*bayerni*, Parr.), and var. *diffusus*, Mouss. Of the latter variety Prof. Böttger possesses specimens without any trace of oral teeth from several localities.

8. Buliminus (Chondrulus) tetrodon, *Mortillet.*

Hab. Seir.

A rare species, occurring also in Armenia and Transcaucasia near Tiflis.

9. Buliminus (Chondrulus) didymodus, *Böttger.*

Hab. Koyun Daghi.

The series of specimens exhibit considerable variation in size, the convexity or flatness of the whorls, and the general form, but the armature of the aperture is very constant.

10. Buliminus (Amphiscopus) continens, *Rosen.**

Hab. Koyun Daghi.

Three rather short examples, 6 millim. long.

* Nachrichtsblatt deutsch. Malak. Gesell. 1892, p. 125.

11. Pupa granum, *Draparnaud.*
Hab. Koyun Daghi.

12. Pupa signata, *Mousson.*
Hab. Koyun Daghi.

13. Limnæa stagnalis, *Linn.*
Hab. Urmi district (?).

14. Limnæa palustris, *Müller.*
Hab. Maragha.

15. Limnæa truncatula, *Müller.*
Hab. Seir.

16. Planorbis marginatus, *Draparnaud.*
Hab. Maragha.

17. Sphærium lacustre, *Müller.*
Hab. Town ditch, Urmi.

18. Unio Sieversi, *Drouet*, var. Kobelti.
Hab. River Gâder near Ocksa.
Prof. Böttger considers this form distinct from *U. batavus*, with which I had united it.

The collection, presented by Mr. Günther, although containing few specimens of each species, and mostly in poor condition, forms a useful addition to the Museum collection, which contains but very few specimens from the north-western part of Persia. Their value is also considerably enhanced by their having been partly named, or their names confirmed, by Prof. Böttger. Most of the species quoted are extremely common forms, having a wide geographical range in the South and South-east of Europe and Turkey in Asia. Their distribution is well known and fully recorded in various works. Westerlund's 'Fauna der paläarctischen Region,' and Rossmässler's 'Iconographie der Land- und Süsswasser-Mollusken, etc.' should be consulted for such information, references, and figures.

CRUSTACEA.

By Robert T. Günther, M.A., F.R.G.S.

(Plate 25.)

MALACOSTRACA.

Decapoda.

Macrura.

I was unable to discover that the Crayfish is known from any of the streams that flow into the lake. It is abundant in the Kur. The Syrian zoologist does not differentiate between crabs and crayfish: to him both are 'Kédjala' and unclean.

Brachyura.

Telphusa fluviatilis, *L.*

This freshwater crab is extremely common in all the rivers. They are to be found beneath stones and in little burrows in wet banks. A favourite attitude is sitting half in and half out of the water, so that they are able to pass either air or water at pleasure through the branchial chamber. They seemed to be able to employ the openings into the branchial chamber either as exhalant or as inhalant apertures. Indeed, instead of continually propelling water through the branchial chamber in the same direction, they were continually changing the direction, and using the apertures at the anterior margin of the carapace and at the axils of the ambulatory appendages alternately as inhalant and exhalant apertures.

When sitting *regardant*, their eyestalks and feelers are set at an angle of 45° with the antero-posterior axis of the body. In colour they are of a greenish-sepia hue, often tending more to green in older specimens, owing to the growth of a green alga on the carapace. The chelæ and ambulatory limbs are generally tipped with orange-red, and their sides are often streaked with a purplish tinge.

The Persian specimens do not appear to differ essentially from those of Italy, Greece, and Palestine which are preserved in the National Collection in the British Museum.

Isopoda.

Hemilepistus.

Common under stones in damp places at Seir.

Asellus, which is so common in all European waters, seemed to be entirely absent in the Urmi basin. It is said to occur in the western tributaries of the Caspian, but not in Russian Turkestan or N.E. Persia.

Amphipoda.

Gammarus pulex, *De Geer*.

In the springs near Seir, and also on the other side of the lake in the clear water of a stream near Kirjawa. My observations confirm those of Dr. Walter in regard to the fact that *G. pulex* seems to prefer the cool, upper, narrow courses of the streams to the warmer, more sluggish, lower reaches in the plains.

ENTOMOSTRACA.

Copepoda.

A Cyclopid was very common in a pond near Kirjawa, Maragha, but I was not able to determine the species.

Phyllopoda.

Daphnia sp.

Common in the stagnant water of the ditch surrounding the walls of the town of Urmi; also at Kirjawa.

Artemia urmiana, sp. n. (Pl. 25.)

The general shape of the body is similar to that of *A. salina*, but stouter than in the American species. The males are somewhat shorter than the females, in the proportion of 10 mm. to 13 mm. The head and "thorax," bearing the eleven swimming-appendages, are very slender, and measured together are nearly equal to the abdomen in length. The segmentation of the abdomen is so difficult to recognize that I am inclined to regard the segmentation as having been partially lost. The first two or three abdominal segments are the only ones clearly distinguishable. The labrum is well developed and is bent over the mouth so as to hide the mandibles. Its distal end is square-ended, with two papilliform processes at the corners; the processes bear small tufts of hairs at their apices, and are probably sensory in function.

The ventral appendage of the genital segment differs greatly in the two sexes. In the female it has the function of an ovisac and usually contains ripe eggs. Its shape has been described as resembling that of broad flask. When quite ripe the eggs

escape through a transverse slit just below the apex of the ovisac. The ovaries extend into the posterior thoracic and anterior abdominal segments. The eggs vary from about ·25 to ·3 mm. in diameter.

In the male the vasa deferentia open at the slightly expanded extremities of a V-shaped organ, which probably contains paired sperm-sacs and ductus ejaculatoria. The distance between the external sexual apertures exactly corresponds to that between the two processes on the claspers, which will be described below, and which I am inclined to consider as being employed for the purpose of transferring the spermatozoa to the female. Near the base of each of the two processes, and on its inner aspect, is a small spinular process with a sharp tooth.

The abdomen terminates in a slight dilatation, within which numerous rectal muscles arranged radially and obliquely traverse the space between the body-wall and the rectum. The anus is terminal and is flanked by two small lateral furcal lobes, upon which are implanted two simple non-plumose setæ in the males, but none in the females. In respect of the scant development of these setæ, *A. urmiana* approximates to the condition of *A. mülhausenii*, as Schmankewitsch described it, from brine of sp. gr. 1·2015, rather than the form from brine of 1·1373 sp. gr., which was provided with one or two, though seldom three, setæ. At the same time it must be remembered that *A. urmiana* has lived for a longer time in its water of sp. gr. 1·1138 than Schmankewitsch's type from water of sp. gr. 1·1373, and has therefore had a longer time to develop those anatomical characters which seem to be the direct result of life in brine.

Appendages.—The antennæ are sometimes twice the length of the eyes and eyestalks. The joints seem to vary in number and relative proportion; as many as five may be distinguished in some individuals. The terminal joint bears three sensory hairs.

The claspers are enormously developed in the adult males, and may measure as much as 4 mm. across. The proximal joints are much thickened, and carry upon their inner faces two rounded processes which are used for clutching the females, and which are probably of service in transferring the spermatozoa (spermatophores?) to the females from the two lateral expansions of the male genital organs. The second joint is large, flattened and triangular in shape; it terminates in a pointed process which is often incurved.

The female homologues of the claspers are insignificant in comparison, their width not exceeding 1·5 mm. across.

Mandibles are powerful, with a finely serrated margin and a palp which does not appear to be always present.

Maxillæ are in two pairs. The first is provided with a tuft of anteriorly directed setæ.

The eleven natatory appendages are all constructed on the same plan. Their axes all bear two respiratory bracts upon one margin and five endites upon the other. The 6th endite is terminal. The 1st or proximal endite bears extremely numerous close-set setæ upon its two lobes in all the swimming-appendages except the last, in which the setæ of the distal lobe are longer and not so closely set as upon the longer proximal lobe.

Endites 2, 3, and 4 are small and only bear 3, 2, and 1 setæ apiece, respectively. The 5th endite has a rounded margin provided with numerous setæ armed with reflected barbs. Such barbed setæ do not appear to be present on any specimens of *A. salina* which I have had the opportunity of examining, and they are certainly absent in some specimens from Guernsey which were given to me by the Rev. Canon Norman. The setæ upon the distal portions of the margin are much longer than those on the proximal portion, and more nearly resemble the long swimming-setæ borne by the terminal endite.

The extraordinary numbers in which the Artemia is found in Lake Urmi have already been referred to (p. 357). The females, as in Lake Utah, were present in greater numbers than the males, in the proportion of 5 : 3. Many of the males were holding on behind the ovisacs of the females by means of their claspers, and with such strength that immersion in alcohol did not cause them to separate, even after death. Consequently, although parthenogenesis may have been a mode of reproduction, it was by no means the only one in August.

The Artemias swim by synchronous movements of the eleven natatory appendages, which are moved at the rate of 160 strokes per minute.

In colour the males incline to a pale greenish, and the females to a more reddish hue. The alimentary canal is usually dark brownish green, owing to the food contained in it.

It is a debatable point whether new specific names should be applied to newly discovered members of a group of animals of which the other species have been mainly diagnosed by

characters of doubtful taxonomic value. *Artemia salina*, *A. mülhausenii*, *A. fertilis*, *A. gracilis*, *A. monica*, and *A. utahensis* have all been distinguished by characters which vary to a greater or less extent with the salinity of the water in which they live. I am inclined to agree with Packard that only two well-defined species of *Artemia* have been described, viz., the Old-World form *A. salina*, with which *A. mülhausenii* (or *Artemia* sp. gr. 1·2015) has been proved by Schmankewitsch to be identical, and the New-World *A. gracilis*, including Verrill's other American species as synonyms. At the same time it is possible that, when a complete revision of the group is made and more minute details are taken into account, other and better specific differences may be found to exist. In the meantime, in order to attract notice to its peculiar features, I venture to propose *Artemia urmiana* as a new Old-World species, with the following diagnosis:—

A. URMIANA, sp. n.

Resembling *A. salina*, but with an incompletely-segmented abdomen; furcal lobes bearing a single seta apiece in the male and none in the female; claspers of male of larger size than in the male *A. salina*; labrum with two sensory setose papillæ. The margin of the fifth endites of the thoracic feet bordered with short setæ bearing barbs of peculiar nature.

Hab. Lake Urmi, in water of specific gravity 1·1138.

EXPLANATION OF PLATE 25.

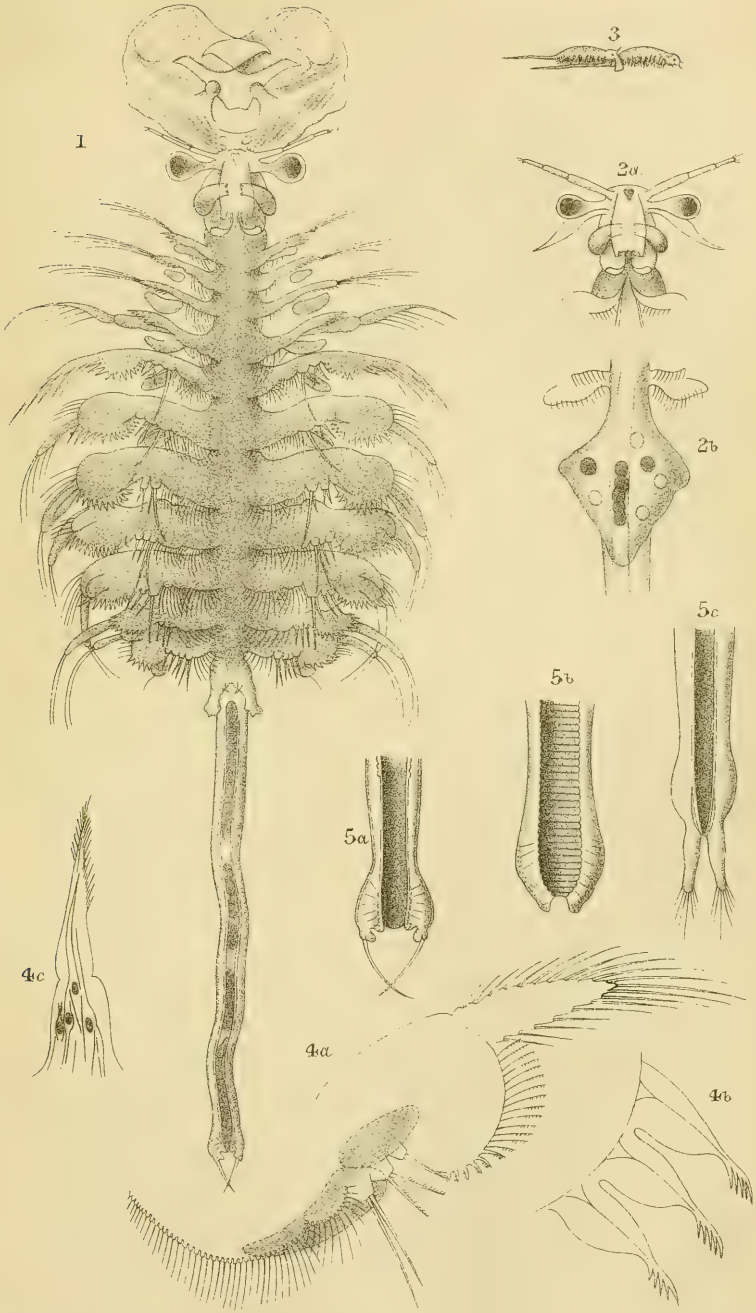
Fig. 1. *Artemia urmiana*, sp. n. Ventral view of male. × 15.

2. *a*. Ventral view of head of female. × 15. *b*. Ventral view of ovisac of female.

3. Lateral view, showing the position of the male when in the act of clasping the female. Twice natural size.

4. *a*. Postabdomen of ♂ *Artemia urmiana*. *b*. Postabdomen of ♀ *Artemia urmiana*. *c*. Postabdomen of ♀ *Artemia salina* (Coll. Norman).

5. *a*. The ventral margin of the seventh thoracic natatory appendage. × 40. The flabellum and bract are indicated by dotted lines. *b*. Barbed setæ from margin of the fifth endite. × 400. *c*. Sensory seta.



M.P.Parker del. et lith.

Geo. West & Sons imp.

ARTEMIA URMIANA.

CHILOPODA AND ARACHNIDA.

By R. I. Pocock, of the British Museum (Natural History).

(Plate 26.)

Class CHILOPODA.

Genus Scutigera, *Latr.*

Scutigera coleoptrata (*Linn.*).

Syst. Nat. ed. x. i. p. 637.

[For synonymy, *see* Latzel, Die Myriop. Oester.-Ungar. Mon. i. p. 25 (1880).]

Loc. Seir.

Ranges from Madeira and Spain throughout South Europe.

Genus Lithobius, *Leach.*

Lithobius persicus, sp. n.

Colour a uniform reddish brown as in *L. forficatus*. *Head* smooth, furnished on each side with about 15 ocelli arranged in four rows. *Antennæ* long, composed of about 42 segments, the exact number being doubtful on account of the indistinctness of the divisional line between some of the segments. *Tergal plates* smooth, the posterior sparsely punctured and hairy; the posterior lateral angles of the 11th not produced beyond the level of the posterior border; those of the 13th produced and spiniform, as for example in *L. forficatus*; the posterior angle of the remaining terga not produced. *Coxal teeth* of external maxillipedes 2–2. Coxal pores of posterior four pairs of legs 3, 5, 4, 5.

Anal leg with single claw; armed below with 0, 1, 3, 3, 1 spines, the coxa with a single external lateral spine. Tibia of anal leg and of preanal leg longitudinally sulcate above in the male; these appendages otherwise not modified.

Total length 19 mm.

Loc. Seir. A single male example.

Very closely allied to the common European species *L. mutabilis*, L. Koch, but apparently distinct on account of the presence of the lateral spine on the anal coxa and of the dentiform prolongation of the 13th tergite.

Genus Scolopendra, *Linn.*

Scolopendra canidens, *Newp.*

Scolopendra canidens, Newp. Ann. Mag. Nat. Hist. xiii. p. 98 (1844); id. Tr. Linn. Soc. xix. p. 399 (1845); id. Cat. Myr. Brit. Mus. pt. i. p. 48 (1856).

Scolopendra affinis, Newp. Ann. Mag. Nat. Hist. xiii. p. 98 (1844); id. Tr. Linn. Soc. xix. p. 386 (1845); id. Cat. Myr. Brit. Mus. pt. i. p. 33 (1856).

Scolopendra oraniensis, Lucas, Rev. Zool. 1846, p. 287; id. Expl. Sci. de l'Algérie, Anim. Art. p. 344.

Scolopendra dalmatica, C. Koch (1847); and recent authors.

Loc. Seir. A single specimen.

Although abundant in North Africa and South Europe, I am not aware that this species has ere this been recorded farther to the east than Egypt.

Class ARACHNIDA.

Order Araneæ.

Genus Argiope, *Sav.*

Argiope Bruennichi (*Scop.*).

Aranea Bruennichi, Scopoli, Obs. Zool. in Ann. V. Hist. Nat. p. 125 (1772).

[For synonymy, *see* Thorell, Remarks on Synonyms, &c. p. 518.]

Loc. Seir.

Widely distributed throughout Central and South Europe, and extending as far north as Paris, Hungary, &c.

Genus Tetragnatha, *Latr.*

Tetragnatha extensa (*Linn.*).

Aranea extensa, Linn. Syst. Nat. ed. x. i. p. 621 (1758).

[For synonymy, *see* Thorell, *loc. cit.* p. 459.]

Loc. Seir.

A single male example, identical with British examples of the species of *Tetragnatha* referred to *T. extensa* (Linn.).

Genus Lathrodectus, *Walck.*

Lathrodectus tredecim-guttatus (*Rossi*).

Aranea 13-*guttata*, Rossi, Fauna Etr. ii. p. 136 (1790).

[For synonymy, *see* Thorell, *loc. cit.* p. 508.]

Loc. Seir.

A single specimen of the black variety of the species (var. *erebus*, Sav.) was found.

Genus Lycosa, *Latr.*

Lycosa Guentheri, sp. n. (Pl. 26. figs. 1, 1 *a*, 1 *b*.)

♀. *Colour.* Carapace with two broad brown bands extending from the eyes to the posterior margin on each side of the pedicel, separated by a flavous median band about equal to them in width; a flavous band of about the same width running along the lateral border; abdomen yellowish white, with two fuscous bands extending along each side of the upper surface from the anterior to the posterior extremity, and a median dark band between them, distinct on the anterior half of the upper surface but breaking up and becoming obsolete posteriorly; sides and lower surface of abdomen yellowish white, with narrow indistinct abbreviated lines behind the epigastric fold; legs yellowish, infuscate distally, sometimes mottled with fuscous spots above; underside of femora yellow, of tibiæ yellow at base, becoming fuscous distally; tibia of 4th leg with two black bands, one apical and one basal, the basal sometimes obsolete; tibia of 3rd leg sometimes with apical band; coxæ and sternum flavous; mandible black in the apical half, yellow above; palpi flavous, with tarsus black.

Carapace about as long as patella and tibia of 1st leg and as protarsus of 4th, barely as long as patella and tibia of the 4th; width of carapace about equal to tibia of 4th and exceeding that of 1st; posterior median eyes not much more than half a diameter apart; eyes of anterior line narrower than those of the median line by about half the radius of one of the latter on each side, only slightly procurved, the upper edge of the laterals above the centres of the medians, the medians only slightly the larger; the laterals almost their own diameter below the posterior medians.

Mandibles clothed above and externally with yellow hairs, black internally and at the apex; posterior border of sulcus armed with 3 subequal teeth.

Legs 4, 1, 2, 3 in length, longish and slender; tibiæ of 3rd and 4th with two spines above; patellæ of 1st unarmed, of 2nd armed with a minute anterior spine, of 3rd and 4th spined in front and behind; tarsal scopula of 3rd and 4th divided by a narrow but sharply defined band of setæ.

Vulva as in fig. 1 *b*, Pl. 26.

♂. Carapace barely as long as patella and tibia of 2nd leg, distinctly shorter than those of 1st and of 4th and than protarsus of latter; patellæ of all the legs armed with an anterior and a posterior spine. Palpus as in fig. 1 *a*, Pl. 26.

Measurements in millimetres:—♀. Total length 18; length

of carapace 7·8, width 5·5; length of 1st leg 21, of 2nd 19, of 3rd 18, of 4th 26 (all measured from base of femur); patella and tibia of 1st 7·5, of 4th 8·2; protarsus of 4th 8.

♂. Total length 15; length of carapace 7·6, of 1st leg 24, of 2nd leg 22, of 3rd leg 21, of 4th leg 29; patella and tibia of 1st leg 8·5, of 4th 8·8; protarsus of 4th 9·2.

Loc. Seir.

In size and colouring this species approaches *L. ferox* of Lucas, but may be at once recognized by its higher head, slightly procurved anterior line of eyes, of which the medians and laterals are subequal. A considerable number of Transcaspian species of this genus have been established, and the species that has been here described as new may perhaps belong to one of them; but until reliable figures of the generative organs of both males and females have been published, or until the specific characters have been set forth in tabular form, the satisfactory identification of the species will remain an almost hopeless task.

Order Solifugæ.

Genus Galeodes, *Oliv.*

Galeodes truculentus, sp. n. (Pl. 26. figs. 2, 2 *a*.)

♀. *Colour.* Upper surface of head strongly infuscate, with median lanceolate pale stripe extending back from the black ocular tubercle; mandibles yellow, with a pair of faint fuscous stripes above; femur of palp yellow, lightly infuscate above at the tip; upperside of tibia infuscate, except for the two extremities which are pale; protarsus infuscate almost to its extremity; tarsus lightly infuscate above; distal half of femur and proximal two-thirds of protarsus of 4th leg, and in a lesser degree of the 2nd and 3rd legs, infuscate.

Width of *cephalic plate* almost equal to length of tibia of palp and exceeding the protarsus and half the tarsus of that appendage, equal to the protarsus of the 4th leg and exceeding the protarsus and half the tarsus of that appendage.

Mandibles with inferior fang armed with 5 teeth; 3 small teeth between the two terminal large teeth.

Legs and palpi short; palpus about three and a half times as long as the width of the head; 4th leg about four and a half times the length; spine-armature of legs as in normal *G. arabs* (see Ann. Mag. Nat. Hist. (6) xvi. p. 77).

♂. Coloured as in ♀; inferior mandibular fang armed with

5 teeth, as in that sex. *Flagellum* resembling that of *G. citrinus* and differing from that of the Egyptian form *G. arabs* (or *Lucasii*) in having the basal portion stouter and the distal sensory portion more expanded. Ocular tubercle of normal size, and about one-fifth the width of the head-plate.

Measurements in millimetres:—♀. Total length (not including mandible) 36; width of head 12·5; length of mandible 17, of palpus 43, its tibia 14, protarsus 11, 1st leg 33, 2nd leg 30, 3rd leg 37, 4th leg 56, its tibia 13, protarsus 9.

♂. Total length 32; width of head 8, of ocular tubercle 1·5; length of palp 49, of 4th leg 60.

Loc. ♀ (type), Island of Koyun Daghi on Lake Urmi; ♂, Superghan.

The females of the three species of *Galeodes* from South Persia may be recognized as follows:—

a. Width of cephalic plate almost equal to length of tibia of 4th leg, exceeding protarsus of 4th by more than half the tarsus and only a little shorter than protarsus and tarsus of palp; palpus about three and a half, 4th leg about four and a half times the width of the cephalic plate; cephalic plate and legs more strongly infuscate ..... *truculentus*, sp. n.

b. Width of cephalic plate much less than tibia of 4th and not exceeding protarsus of palp and 4th leg; legs and palpi much longer; cephalic plate and legs scarcely infuscate.

a'. Legs and palpi shorter; palpus a little more than four and a half, 4th leg about six times as long as width of cephalic plate ..... *darius*, Poc.*

b'. Legs and palpi longer; palpus a little more than five times, 4th leg a little less than seven times, as long as the width of cephalic plate.. *citrinus*, Poc.†

The males of the three South Persian species may be recognized as follows:—

a. Ocular tubercle very large, its width about one-third that of the head-plate; palpus longer,

* Ann. Mag. Nat. Hist. (6) xvi. p. 81 (1895). A single female of this species from Fao on the Persian Gulf was sent to the British Museum by Mr. W. D. Cuming.

† *Loc. cit.* The British Museum has received many examples of this species, collected at Jask, on the Gulf of Oman, from Messrs. Butcher, B. T. Ffinch, and F. W. Townsend.

seven times as long as width of head; tibia, protarsus, and tarsus completely black; distal tarsal segment of 2nd and 3rd legs with two anterior spines ..... *cyrus*, Poc.*

b. Ocular tubercle much smaller, its width about one-fifth that of the head-plate; palpus shorter, only about six times as long as the width of the head; the tibia pale at the apices; tarsus scarcely infuscate; distal tarsal segment of 2nd and 3rd legs with one anterior spine.

a'. Cephalic plate, legs, and femur of palpus scarcely noticeably infuscate; lower fang of mandible with only 1 small supernumerary tooth between the two larger teeth ..... *citrinus*, Poc.

b'. Cephalic plate, posterior legs, and femur of palpus distinctly infuscate; lower fang of mandible with 3 supernumerary teeth..... *truculentus*, sp. n.

Order Scorpiones.

Genus Buthus, *Leach*.

Buthus caucasicus (*Fischer*).

Scorpio caucasicus, Fischer, Zoogn. p. 401, pl. iv. fig. 1 (1813) (= *eupeus* and *thersites*, C. Koch).

Subsp. persicus, nov.

Colour. Tergites yellow with five black stripes, three marking the keels and one on each side between the lateral keels and the border; carapace correspondingly marked in its posterior half; in its anterior half the tubercle, the frontal keels, and the anterior border are black, and there is a black patch on each side between the ocular tubercle and the lateral margin; median and lateral inferior caudal keels black; palpi yellow, with traces of black lines on the humerus, brachium, and hand; femur and patella (tibia) of legs also partially infuscate.

Structurally this Scorpion much resembles *B. afghanus*, Poc. (Tr. Linn. Soc. (2) iii. p. 116, 1889), from Meshed in Afghanistan; but the tail is considerably more powerful in *B. persicus*, the segments being relatively both higher and broader. For example, the height of the 3rd segment in the ♂ is about equal to the length of the inferior keel, and that of the ♀ a little less, whereas in *afghanus* (♂ ♀) the height is noticeably less. Again,

* Ann. Mag. Nat. Hist. (6) xvi. p. 79 (1895). Based upon a single male example from Fao (*W. D. Cuming*).

although the tail is more powerful, the crests are very perceptibly less strongly granular. This is particularly noticeable on the inferior median crest of the 2nd and 3rd segments, which in *B. afghanus* are strongly elevated posteriorly, but are scarcely noticeably so in *B. persicus*. Similarly, the inferior lateral keels of the 5th segment are much less strongly denticulate, and the posterior lateral prominence is trilobate, not bilobate.

Pectinal teeth 25–26, ♂; 20–21, ♀.

In the palpi the hands are large, smooth and rounded, not crested in either sex, larger in ♂ than ♀. Fingers more strongly lobate in ♂; in both sexes the movable digit is much longer than the hand-back, and slightly exceeds the length of the brachium; 12 rows of teeth, as in *afghanus*.

Measurements in millimetres:—♂ (type). Total length 49; length of carapace 5·5, of tail 31; height of 3rd segment 3·9; length of inferior keel 3·8, width 4; width of hand 3·4; length of hand-back 4, of movable digit 6.

♀. Total length 61, carapace 6·2, tail 34.

Loc. Seir; landing on east side of lake.

According to Dr. A. Birula, who has examined many Transcaspian Scorpions allied to *afghanus* and *persicus*, *B. afghanus*, Poc., is synonymous with *B. thersites*, C. Koch *, the latter being but a subspecies of *B. eupeus* of C. Koch †. But since the locality of the original *thersites* is unknown, and the description of the specimen or specimens to which Dr. Birula gave that name does not apply to the typical examples of *B. afghanus*, at all events in the form of the 3rd segment of the tail, I prefer to cite the species or subspecies by the name under which I originally described it.

Note.—Subjoined is the description of a new species of the genus *Buthus* from Persia:—

Buthus vesiculatus, sp. n. (Pl. 26. fig. 4.)

Colour of trunk, chelæ, and tail entirely pale yellow. In structural characters, *i. e.*, form of palpi, of cephalothoracic and abdominal keels, closely allied to *B. parthorum*, Poc., from near Meshed (Tr. Linn. Soc. (2) iii. p. 113, 1889), but at once recognizable by the form of the vesicle and the shortness of the aculeus of the tail. In *B. parthorum* the vesicle is small and piriform (Pl. 26. fig. 3), its width exceeding its

* Die Arachn. vi. p. 51, fig. 466 (1839).

† Die Arachn. v. p. 127, fig. 419 (1838).

height, its height being much less than the width of the upper surface of the 5th caudal segment and only a little more than half the length of a straight line drawn from the outer side of the base of the aculeus to its point; the aculeus is very long and lightly curved, its length represented by a straight line, drawn as described above, considerably exceeding the width of the 5th caudal segment, exceeding also the length of the vesicle, equal to half the length of the movable digit and to the distance between the anterior edge of the median eye and the posterior border of the carapace. In *B. vesiculatus*, on the contrary, the vesicle (Pl. 26. fig. 4) is large and globular, the height exceeding the width; the aculeus is short and more strongly curved, its length represented by a straight line drawn as above being much less than, not much more than half, the length of the vesicle, less than the width of the 5th caudal segment, about one-third the length of the movable digit, and much less than half the length of the carapace.

Pectinal teeth 20 in ♀, 25 in ♂.

♀. Total length 55 mm.; length of carapace 65, of tail 33; height of vesicle 3, width 2·8; length of aculeus 2·5. [In type (♀) of *B. parthorum* the measurements, in mm., are:—Total length 74, carapace 8, tail 44; height of vesicle 2·5, width 3; length of aculeus 4·6.]

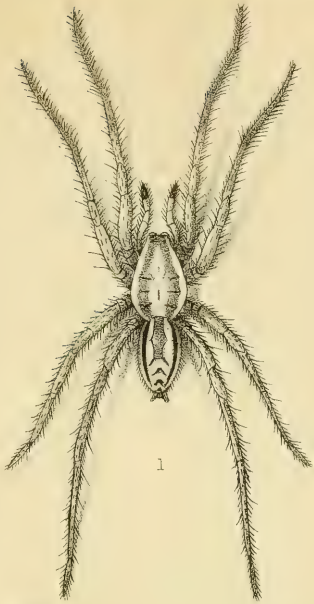
Loc. Astracan, in Persia.

There are three examples of this species in the British Museum: two, ♀ ad. and ♂ immat., from the above locality, and 1 ♀ ad. in bottle without locality but containing other typically Eastern Mediterranean specimens of Arachnida and Chilopoda.

Prof. K. Kraepelin (Das Tierr., Scorpiones, p. 24, 1899) cites *B. parthorum* as doubtfully synonymous with *B. caucasicus*, Nordman (Demidoff, Voy. Russie, iii. p. 731, Arachn. pl. i. fig. 1, 1840). Judging by Kraepelin's description of the latter species, the two are certainly allied: but since nothing is said about the form of the caudal vesicle and aculeus, there is at present no certainty on this point. In any case the name *caucasicus* cannot stand for the species, since it was previously used by Fischer, as Birula has shown, for another species of *Buthus*. Hence, if *caucasicus*, Nord.=*parthorum*, Pocock, the latter will be the name for the species.

EXPLANATION OF PLATE 26.

Fig. 1. *Lycosa Guentheri*, sp. n. Dorsal view, ♂.
1 *a*. ,, ,, Palp of ♂.
1 *b*. ,, ,, Vulva of ♀.
2. *Galeodes truculentus*, sp. n. ♀, nat. size.
2 *a*. ,, ,, Flagellum of ♂.
3. *Buthus parthorum*, Poc. Vesicle and aculeus of tail.
4. ,, *vesiculatus*, sp. n. ,, ,,

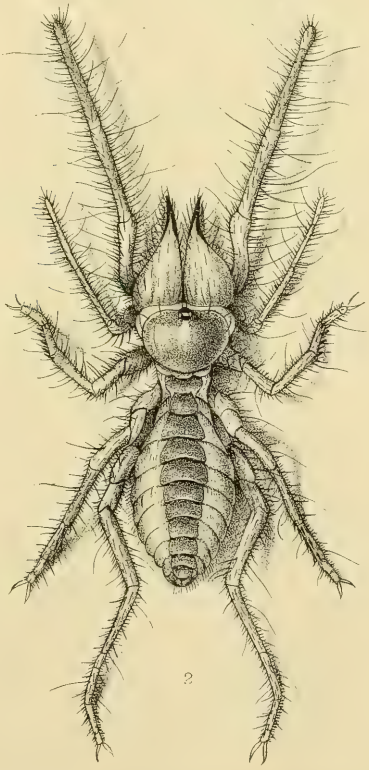


1

1b.

1a.

3



2

2a.

4

F.O.Pickard-Cambridge del. et lith. West, Newman imp.

ARACHNIDA FROM LAKE URMI.

ACARI.

By Albert D. Michael, F.L.S., F.R.M.S.

(Plate 27.)

Among the specimens collected by Mr. R. T. Günther the following three species of Acari have been identified:—

Astoma gryllaria, *le Baron.*

This species, common in the Urmi district, was found attached near the bases of the wings of *Caloptenus italicus*, L., in July. The genus *Astoma* cannot be considered a good one, being founded entirely upon a larval type. The adult form would certainly be one of the Trombidiidæ. *Trombidium sericeum locustarum* was described as the adult form by Riley, but as the *Astoma gryllaria* larva is totally different from the larva of *T. sericeum*, this identification seems doubtful. Riley considered the larva very destructive to locusts and consequently beneficial to man, and brought it into notice in a series of articles ("The Locust in 1876," New York Tribune, Aug. 16, 1876; "Rocky-Mountain Locust," Appleton's Amer. Cyclop. 1875, pp. 371–374; and "Mite Transformations," Trans. Acad. Sci. St. Louis, vol. iii. Proc. p. 267).

Rhipicephalus simus, *C. L. Koch*; or sanguineus, *Latr.*

These are practically world-wide species; dogs and other animals carry them everywhere, and they will attach themselves to almost any creature which has blood to suck.

The Persian specimens were all found upon the hind legs and tails of the *Testudo ibera*, in situations in which they are free from the risk of being rubbed off. All the older tortoises at Seir carried three or four of these bloodsuckers.

Argas persicus, *Fischer.*

Hab. Seir Hill.

This species I regard as synonymous with *Argas reflexus* of Fabricius. I have obtained specimens which are indistinguishable from *A. reflexus* from all quarters of the globe; they are probably transported by pigeons and other birds. In a hot country the bite of this tick is believed occasionally to produce fever, madness, and even death (*cf.* p. 366). Mr. Günther found one specimen upon a tortoise.

A bright orange-coloured species of Acarid was in two instances found attached to the nape of the neck of a species of *Machilis* (Pl. 27. fig. 4).

INSECTA (Lepidoptera Rhopalocera).

By A. G. Butler, Ph.D., F.L.S.

[For the specimens marked "*Daltry collection*" I am much indebted to the energy of the Rev. S. J. Daltry.—R. T. G.]

Nymphalidæ.

Satyrinæ.

1. Hipparchia briseis, var. turanica.
Satyrus turanica, Stgr.; (cf. Rühl, Palæarkt. Gross-schm. i. p. 532 (1892).
Seir, 8 miles west of Urmi, Aug. 13–19 (1898).

2. Hipparchia pelopea.
Satyrus pelopea, Klug, Symb. Phys. 3, pl. xxix. figs. 5–8 (1832).
Seir, 8 miles west of Urmi, Aug. 13–16 (1898).

3. Hipparchia circe.
Papilio circe, Fabricius, Syst. Ent. p. 495 (1775).
♂, Urmi (*Daltry coll.*).

4. Epinephele lycaon, var. lupinus.
Satyrus lupinus, Costa, Faun. Nap. (1835?); Staudinger, Horæ Soc. Ent. Ross. 1870, p. 79.
♀, Seir, 8 miles west of Urmi, Aug. 13–16 (1898).

5. Epinephele hispulla.
Papilio hispulla, Esper, Eur. Schmett. i. 2, pl. cxix. figs. 1, 2 (1809?).
♀ ♀, Urmi (*Daltry coll.*).

6. Erebia afer.
Papilio afer, Esper, Eur. Schmett. pl. lxxxiii. figs. 4, 5 (1783).
Urmi (*Daltry coll.*).

7. Cœnonympha pamphilus.
Papilio pamphilus, Linn. Syst. Nat. x. p. 472 (1758).
Seir, Aug. 19, and Urmi (*Daltry coll.*).

8. Pyrameis cardui.
Papilio cardui, Linn. Faun. Suec. p. 276 (1761).
♂, Urmi (*Daltry coll.*).

9. Argynnis maia.
Papilio maia, Cramer, Pap. Exot. i. pl. xxv. B, C (1775).
♂, Urmi (*Daltry coll.*).

10. Melitæa aurinia.
Papilio aurinia, Rott. Naturf. vi. p. 5 (1775).
♀, Urmi (*Daltry coll.*).

LYCÆNIDÆ.

11. CUPIDO DAMON.

Papilio damon, Schiffermüller, Wien. Verz. p. 182 (1776).

♂, Seir, Aug. 16, 1898.

12. CUPIDO ADMETUS, var. RIPARTII.

♀ *Papilio ripartii*, Freyer, Beitr. Schmett. iii. pl. 133. fig. 3 (1830).

♂ ♂, ♀ ♀, Seir, Aug. 16, 1898.

The males have the veins of the primaries broadly bordered with woolly androconia from the base to beyond the middle. In the specimens from Seir these have been to some extent abraded, but are still easily discernible.

13. CUPIDO ICARUS.

Papilio icarus, Rott. Naturf. vi. p. 21 (1775).

♂ ♂, ♀ ♀, Seir, Aug. 16, 1898.

14. CUPIDO AGESTIS.

Papilio agestis, Schiffermüller, Wien. Verz. p. 184 (1776).

♂ ♂, ♀ ♀, Seir, Aug. 16, 1898.

15. CUPIDO BELLARGUS, var. OCEANUS.

♀ *Papilio oceanus*, Bergstrasser, Nomencl. iii. pl. 53. figs. 3, 4 (1779).

♂, Urmi (*Daltry coll.*).

The female has the submarginal red spots well defined above in this variety, but the male only differs from our *C. adonis* below.

16. CUPIDO ENDYMION.

Papilio endymion, Schiffermüller, Wien. Verz. p. 182 (1776).

Papilio daphnis, id. ibid.

♂ ♂, ♀ ♀, Seir, Aug. 16 & 19, 1898.

17. CUPIDO DAMA, var. ?

Lycæna dama, Staudinger; cf. Rühl, Palæarkt. Gross-schm. p. 287 (1892).

♂ ♂, ♀ ♀, Seir, Aug. 16 & 19, 1898.

This species is new to the Museum series. Mr. Elwes kindly informed me that it was "probably *C. dama*"; the description in Rühl's book does not, however, represent a form like that before me; indeed, the specimens from Seir seem rather to resemble the description of *C. aedon* of Christoph, but both fore and hind wings have the veins entirely blackish, not merely with blackish tips.

18. Chrysophanus thetis.
Lycæna thetis, Klug, Symb. Phys. pl. 40. figs. 17, 18 (1834).
♂ ♀, Seir, Aug. 16.

19. Chrysophanus thersamon, var. omphale.
Lycæna omphale, Klug, Symb. Phys. pl. 40. figs. 12–14 (1834).
♀, Seir, Aug. 16.
It seems hardly likely that this tailed form can be a mere variety of *C. thersamon*, but Dr. Staudinger regards it in that light.

Papilionidæ.

Pierinæ.

20. Colias edusa.
Papilio edusa, Fabricius, Mant. Ins. ii. p. 23 (1787).
♂ ♂, Urmi (*Daltry coll.*); ♂ ♀, Seir, Aug. 13–19, 1898.
Although the names *hyale*, *electra*, and *croceus* all take priority over *edusa*, the later name is so widely recognized that the use of any of them without the general consent of Lepidopterists is likely to lead to misapprehension*. If the name *hyale* be rejected on account of its long application to a different species in the genus, I do not see how *electra* applied to a common African sport of the species can be ignored with any fairness or regard to the law of priority. That *C. electra* is not a species distinct from the European insect is certain, inasmuch as typical forms of both insects with numerous intergrades reach us from the same localities.

21. Synchloë daplidice.
Papilio daplidice, Linnæus, Syst. Nat. 1, ii. p. 760 (1767).
♂, Seir, Aug. 13–16, 1898.

22. Ganoris rapæ, var. ergane.
Papilio ergane, Hübner, Eur. Schmett. i. figs. 904–7 (1827).
Seir, Aug. 13–16, 1898.

Papilioninæ.

23. Thais Cerisyi.
Thais cerisyi, Godart, Mém. Soc. Linn. Paris, ii. pl. 2 (1822).
Urmi (*Daltry coll.*).

* Another objection to the use of the name *edusa* for a *Colias* is that, in his 'Genera Insectorum,' Fabricius used it for *Synchloe daplidice*.

HESPERIIDÆ.

24. CHARCHARODUS ALTHEÆ.
Papilio altheæ, Hübner, Eur. Schmett. i. figs. 452, 453 (1798–1803).
Seir, Aug. 13–16, 1898.

25. ADOPŒA LINEOLA.
Papilio lineola, Ochsenheimer, Schmett. Eur. i. p. 230 (1808).
♂, Urmi (*Daltry coll.*).

26. AUGIADES SYLVANUS?
Papilio sylvanus, Esper, Eur. Schmett. i. 1, pl. 36. fig. 1 (1778?).
♀, Urmi (*Daltry coll.*).
The single example is larger than any specimen of this species which I have seen.

INSECTA (LEPIDOPTERA PHALÆNÆ).

By Sir G. F. HAMPSON, Bart.

THE following species have been identified in the collections made by Mr. R. T. Günther.

SYNTOMIDÆ.

SYNTOMIS PERSICA, *Koll. Denkschr. Akad. Wiss. Wien, Math.-nat. Classe*, i. p. 53 (1850); *Hmpsn. Cat. Lep. Phal. B. M.* i. p. 101, pl. iv. f. 5.
Urmi (*Daltry*), 2 ♂. Only known previously by the type ♂ in bad condition in the Vienna Museum; the patagia are yellowish white.

ARCTIADÆ.

DEIOPEIA PULCHELLA, *Linn. Syst. Nat.* 1, ii. p. 884.
Urmi (*Daltry*), 1 ♀.

NOCTUIDÆ.

AGROTIS YPSILON, *Rott. Naturf.* xi. p. 141.
Urmi (*Daltry*), 1 ♀.

AGROTIS CHRISTOPHI, *Stgr. Berl. e. Zeit.* 1870, p. 110.
Seir near Urmi (*Günther*), 1 ♀; Urmi (*Daltry*), 1 ♂.

HADENA BIMACULOSA, *Linn. Syst. Nat.* xii. p. 856.
Urmi (*Daltry*), 3 ♀.

ACRONYCTA CENTRALIS, *Stgr.*
Urmi (*Daltry*), 2 ♂, 1 ♀.

Ulochlæna hirta, *Hübn. Eur. Schmett., Noct.* f. 591.
Urmi (*Daltry*), 1 ♂.

Episema glaucina, *Esp. Eur. Schmett.* 81. 4, 5.
Urmi (*Daltry*), 1 ♂.

Xanthia ocellaris, *Bork. Nat. Eur. Schmett.* iv. 647.
Urmi (*Daltry*), 1 ♂.

Bryophila perla, *Schiff. Wien. Verz.* p. 70.
Urmi (*Günther*), 1 ♂.

Tarache luctuosa, *Schiff. Wien. Verz.* p. 90.
Urmi (*Daltry*), 1 ♂.

Tarache sulphuralis, *Linn. Syst. Nat.* i. 2. p. 881.
Urmi (*Daltry*), 2 ♂.

Xanthoptera triangularis, *Warr. P. Z. S.* 1888, p. 309.
Urmi (*Günther*), 1 ♂.

Catocala neonympha, *Esp. Eur. Schmett.* 198. 1, 2.
Urmi (*Daltry*), 1 ♂.

Catocala elocata, *Esp. Eur. Schmett.* 99. 1, 2.
Urmi (*Daltry*), 2 ♂; Seir (*Günther*), 2 ♂.

Euclidia mi, *Clerck, Icones*, pl. 9. f. 5.
Urmi (*Daltry*), 1 ♂.

Lymantriadæ.

Lymantria dispar, *Linn. Syst. Nat.* x. 501.
Urmi (*Daltry*), 1 ♂.

Saturniadæ.

Saturnia pyri, *Schiff. Wien. Verz.* p. 49.
Urmi (*Daltry*), 1 ♂.

Sphingidæ.

Smerinthus populi, *Linn. Syst. Nat.* x. p. 489.
Urmi (*Daltry*), 1 ♂.

Macroglossa stellatarum, *Linn. Syst. Nat.* x. p. 493.
Urmi (*Daltry*), 1 ♂.

Notodontidæ.

Dicranura vinula, *Linn. Syst. Nat.* x. p. 499.
Urmi (*Daltry*), 1 ♂.

GEOMETRIDÆ.

MACARIA MURINARIA, *Schiff. Wien. Verz.* p. 105.
Urmi (*Günther*), 1 ♀.

ANAITIS PLAGIATA, *Linn. Syst. Nat.* x. p. 526.
Urmi (*Daltry*), 1 ♂.

ANAITIS USGENTARIA, *Stgr.*
Urmi (*Daltry*), 1 ♀.

CATACLYSME BILINEATA, *Linn. Syst. Nat.* x. p. 525.
Urmi (*Daltry*), 1 ♂, 1 ♀.

EUPITHECIA SUBUMBRATA, *Schiff. Wien. Verz.* p. 110.
Urmi (*Günther*), 2 ♂, 1 ♀.

RHODOSTROPHIA CALABRARIA, *Zell. Stett. e. Zeit.* 1852, p. 180.
Urmi (*Daltry*), 2 ♂.

RHODOSTROPHIA INCONSPICUA, *Butl. P. Z. S.* 1886, p. 391.
Urmi (*Daltry*), 1 ♂.

CRASPEDIA MARGINEPUNCTATA, *Goeze, Beytr.* iii. 3, p. 385.
Urmi (*Daltry*), 1 ♂.

LASIOCAMPIDÆ.

METANASTRIA TRIFOLII, *Schiff. Wien. Verz.* p. 53.
Ab. *terreni*, H.-S. Eur. Schmett. ff. 120, 121.
Transcaucasia, Kivorak (*Günther*), 1 ♂.

CLISIOCAMPA CASTRENSIS, *Linn. Syst. Nat.* x. p. 500.
Urmi (*Daltry*), 2 ♀ of a very pale form.

PSYCHIDÆ.

APTERONA CRENULELLA, *Bruand. Mon. Psych.* p. 76, f. 49.
Urmi (*Günther*), 3 larva-cases on a piece of bark.

ZYGÆNIDÆ.

ZYGÆNA CUVIERI, *Boisd. Mon. Zyg.* iii. 6, p. 53.
Urmi (*Daltry*), 1 ♂.

PYRALIDÆ.

HETEROGRAPHIS PYRETHRELLA, *Herr.-Schäff. Neue Schmett.* 80, p. 12.
Seir, near Urmi (*Günther*), 1 ♂.

Aglossa pinguinalis, *Linn. Syst. Nat.* x. p. 533.
Urmi (*Günther*), 1 ♂.

Pyralis farinalis, *Linn. Syst. Nat.* x. p. 226.
Urmi (*Daltry*), 1 ♂.

Hypsopygia costalis, *Fabr. Syst. Ent.* p. 132.
Seir, near Urmi (*Günther*), 2 ♂.

Scoparia cembræ, *Haworth, Lep. Br.* p. 498.
Seir, near Urmi (*Günther*), 2 ♂.

Nomophila noctuella, *Schiff. Wien. Verz.* p. 136.
Seir, near Urmi (*Günther*), 1 ♂.

Pyrausta cespitalis, *Schiff. Wien. Verz.* p. 123.
Seir, near Urmi (*Günther*), 2 ♂.

Pyrausta aurata, *Scop. Ent. Carn.* no. 565.
Seir, near Urmi (*Günther*), 1 ♂.

Orneodidæ.

Orneodes sp.
Seir, near Urmi (*Günther*), 2 ♂.

Tineidæ.

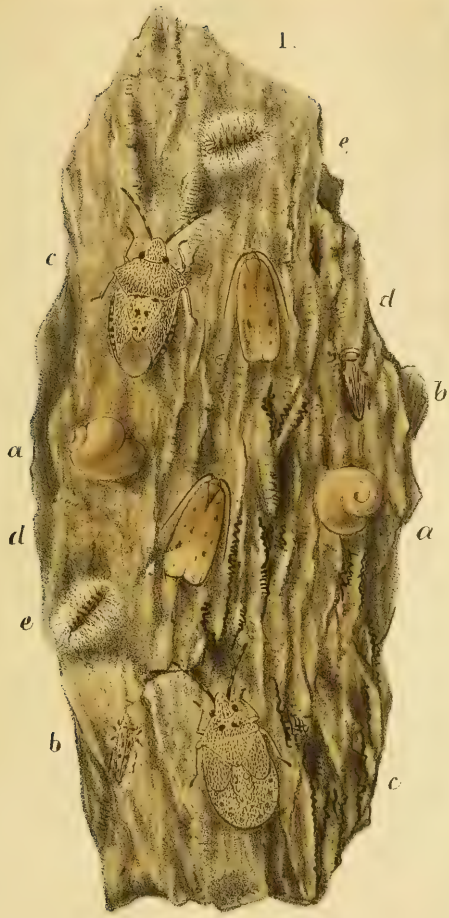
Three species undetermined.

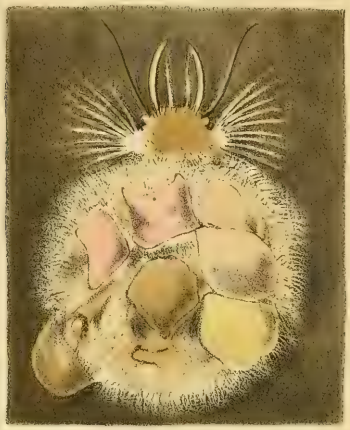
NEUROPTERA (Hemerobiidæ) and DIPTERA.

By Robert T. Günther, M.A., F.R.G.S.

(Plate 27.)

On Plate 27. fig. 2 is figured the larva of one of the Hemerobiidæ or Lacewing flies, which both in structure and habit is related to the larva of *Chrysopa perla*, and is not unlike the larva of an *Hemerobius*? figured by Sowerby in his 'British Miscellany,' pl. 66. The entire animal was hardly larger than a hemp-seed; the body is long and distinctly segmented; the head carries a pair of powerful mandibles, which are about one-third of the length of the body. The labial palps are at least 3-jointed, and the antennæ are longer than the mandibles and are unjointed. Immediately behind the conspicuous eyes are two knobs, each bearing a tuft of some two dozen white hairs; to these succeed four





INSECTA AND ACARID FROM LAKE URMI .

other pairs of similarly tufted basal knobs borne by the succeeding tergal portions of the segments. The posterior tufts carry a large globular mass of white cottony threads, like American blight, in which are entangled the inedible portions of the carcases of its prey. Upon a specimen captured on rocks near Seir the dry cuticle of a small spider was distinguishable.

DIPTERA.

Ephydra urmiana, sp. n. (Plate 27. fig. 3.)

The larvæ which are found in considerable numbers near the margin of the lake are so similar to the larvæ of *Ephydra salinaria* which were observed by Klug in "Salzsiederei" in Silesia, and described by Loew, and to the halophilous larvæ of *Ephydra* described by Packard, that I have no hesitation in referring them to the same genus. At the same time, the larva of the *Ephydra* of Lake Urmi does not agree with either *E. salinaria* or with *E. halophila*, and it is to accentuate this fact that I have ventured to base a new species upon a larval form.

The larvæ of *E. urmiana* caught on July 21st near Superghan were whitish in colour, and about 10 millim. long. The body is composed of eleven segments, nearly cylindrical, and pointed anteriorly but terminating bluntly behind, unlike the larva of *E. salinaria* (Westwood, Introduction, fig. 132, no. 11). The last segment is prolonged dorsally into a long bifurcated respiratory process, three-sevenths the length of the body, and containing two tracheal vessels which open by two spiracles situated at the tips of the two branches. Mouth-parts present. All but the first three smaller segments are provided with two groups of chitinous bristles, mounted on inconspicuous tubercles. Abdominal appendages, like those of the larva of *E. halophila*, absent.

The rarity of halophilous insects must enhance the interest attaching to the particulars of their life-histories, and consequently it is much to be desired that some naturalist should endeavour to rear the adult imago of this remarkable fly. The only other species of Diptera which have been recorded, so far as I am aware, from very salt water are:—

Ephydra salinaria (*Halmopota salinaria*) in Silesia, Dürrenberg, &c. (Westwood, loc. cit.; Bouché, Naturg.; Loew, Zeit. Naturwiss, Halle, 1867).

Ephydra halophila in Illinois. (Packard, Proc. Essex Inst. vi. 1869; Verrill, Proc. Boston Soc. 1866.)

Chironomus oceanicus in Salem Harbour. (Packard, loc. cit.)

Chironomus sp. in Utah. (Stansbury, Report on Valley of Great Salt Lake of Utah.)

Halophilus in Illinois and Salem Harbour. (Packard, loc. cit.).

EXPLANATION OF PLATE 27.

Fig. 1. Group of insects upon the bark of *Populus alba* (p. 367).
a. Larva-cases of *Apterona crenulella*. *b*. *Bathyscopus pocillus*. *c*. *Pentatoma baccarum* (?) *. *d*. *Yponomeuta padellus*, L. *e*. Moulted skin of larval insect.
2. Larva of *Hemerobius* sp.
3. Larva of *Ephydra urmiana*.
4. Acarid upon *Machilis persa* (?).

* Or some allied species. The identification is that of Mr. C. O. Waterhouse.

ORTHOPTERA.

By Malcolm Burr, F.Z.S., F.E.S.

The small collection of Orthoptera made by Mr. R. T. Günther in North-west Persia contains twelve species, of which one is a new variety of a well-known species. The most interesting capture, perhaps, is the *Decticus assimilis* Fieb.

It is unfortunate that they have been preserved in spirit, which has bleached the colours of all, especially of the Œdipodidæ.

Forficularia.

Forficula auricularia, *L.*

Seir, N.W. Persia. 2 ♂, 1 ♀.

The two males represent the variety figured by Fischer (Orth. Eur. tab. vi. fig. 11 *l*). The Marquis Doria captured the same form in Northern Persia some years ago, and quite recently a similar specimen, undoubtedly British, was exhibited at the South London Natural History Society. It differs from the type in the narrowness of the dilated part of the male forceps above the tooth.

In the typical form the part of the forceps from base to this tooth is contiguous, the sides of the branches being parallel. In this variety the inner margins of the basal part diverge, making roughly a triangular area between the pygidium and the teeth of the forceps.

Mantodea.

Bolivaria brachyptera, *Pall.*

Seir, 2 ♂, 6 ♀; Koyun Daghi, 1 ♂, 1 ♀.

This species is common in Southern Russia, the Caucasus and Asia Minor.

Acridiodea.

Truxalidæ.

Truxalis unguiculata, *Ramb.*

Seir. 1 ♀. A widely distributed species.

Œdipodidæ.

Œdipoda Schochii, *Br.*

Seir, Aug. 16, 1898. 1 ♀.

This specimen, of which the wings have been bleached by the spirit, is 35 millim. in length; de Saussure gives 32 millim. as the dimensions of the female. Recorded from Aleppo and the Caucasus.

Sphingonotus satrapes, *Sauss.*?

Seir, Aug. 16, 1898. 1 ♂.

This specimen does not agree perfectly with de Saussure's description, the posterior femora showing no black; but this character may have well been destroyed by the spirit, which has considerably bleached it. The colour of the wings has entirely gone, leaving a whitish base, with the black fascia. I hesitate to regard it as distinct.

Œdalius nigrofasciatus, *De Geer.*

Seir, Aug. 16, 1898. 1 ♀.

Pyrgodera cristata, *F. de W.*

Seir, Aug. 16, 1898. 1 ♂.

A native of temperate Asia and Eastern Europe.

Acridiidæ.

Caloptenus italicus, L.

Found at Superghan, July 22nd, infested with *Astoma gryllaria* (see p. 407).

Pyrgomorphidæ.

Pyrgomorpha grylloides, *Latr.*, var. nov. Guentheri.

Seir. 4 ♀.

A *P. grylloide* typico differt, elytris alisque, in feminis saltem abbreviatis, segmentum abdominale quintum attingentibus.

The shortness of the elytra and wings gives this form an appearance different from the type, but the comparative development of organs of flight in Orthoptera is too slender a character on which to base a species.

Locustodea.

Decticidæ.

Pachytrachelus sp.

Seir, Aug. 16, 1898. 1 ♀.

This is very probably a new species, but it is impossible to describe it without the male. It is close to *P. striolatus*, Fieb.

Decticus assimilis, Fieb.

Seir. 2 ♀.

Both these specimens are considerably larger than an example in my collection from Tiflis, approaching more nearly to *D. albifrons*, Fabr., in size and appearance. It has hitherto been recorded by Brunner and Fieber from "Tiflis and Syria."

Gryllodea.

Gryllotalpidæ.

Gryllotalpa gryllotalpa, *L.*

Seir, Urmi. Several specimens, in all stages of development.

Mole-crickets were always abundant, but at the same time I never met the swarms which have been described from the neighbourhood of Ispahan and Shiraz, where one intelligent observer estimated their numbers at one to every square fathom over an area of many square miles.—R. T. G.)

NOTE ON A JURASSIC AMMONITE.

By G. C. Crick, F.G.S., of the British Museum (Natural History).

The only Jurassic fossil in Mr. R. T. Günther's collection is an Ammonite preserved on the surface of a small block of limestone of reddish-brown colour. It consists of a portion of the outer whorl that has been much flattened during fossilization, and of the impression of the greater part of the rest of the shell.

Jurassic Ammonites have been recorded from N.W. Persia by

Weithofer* and by Borne †; and the present specimen is doubtless referable to *Perisphinctes curvicosta*, Oppel, sp. ‡, a species which Borne has recorded and figured (*op. cit.* p. 14, pl. i. fig. 1; pl. iv. fig. 14) from rocks of Callovian age in the neighbourhood of Maragha, whence the present specimen is believed to have come.

FOSSIL ECHINOIDEA.

By J. W. Gregory, D.Sc., F.G.S.

(Plate 28.)

Mr. Günther's collection of Echinoidea consists of five specimens all of which belong to the genus *Clypeaster*. According to Mr. Günther, they are "said to have come from Guverchin Kala, at the extreme northern end of Lake Urmi." This locality is no doubt the same as the Guverchine Kalak where the Hon. W. K. Loftus made a collection of fossils now in the British Museum.

Miocene Echinoidea from Lake Urmi have been described by Abich §, who has recorded thence eight species of *Clypeaster*.

1. Clypeaster aff. imperialis, *Michelin* ‖, 1861. (Plate 28. fig. 1.)

The most massive Clypeaster in the collection is unfortunately so much broken on the margin and base that its positive determination is impossible. But it clearly belongs to the group of Clypeasters of which *C. olisiponensis*, Mich. ¶, may be taken as the type. From that species the Urmi echinid differs by having

* K. Weithofer, "Ueber Jura und Kreide im nordwestlichen Persien": Sitzungsb. d. k.-k. Akad. Wissensch. Wien, Bd. xcviii. Abth. 1, Dec. 1889.

† G. v. dem Borne, 'Der Jura am Ostufer des Urmiasees.' Inaugural Dissertation. Halle, 1891.

‡ A. Oppel, 'Die Juraformation,' p. 555 (1857). See also J. v. Siemiradzki, "Monographische Beschreibung der Ammonitengattung *Perisphinctes*": Palæontographica, Bd. xlv. p. 96, 1898.

§ H. Abich, "Ueber das Steinsalz und seine geologische Stellung im Russischen Armenien," Mém. Ac. Imp. Sci. St. Pétersb. ser. 6, vol. ix. pt. 1, Mém. Sci. Math.-Phys. vol. vii. 1859, pp. 111–114; and 'Geologische Forschungen in den Kaukasischen Ländern, Abth. ii. Geologie der Armenischen Hochlandes,' i. 1882, pp. 223–225, 270–283.

‖ H. Michelin, "Monographie des Clypéastres fossiles," Mém. Soc. Géol. France, ser. 2, vol. vii. p. 118, pl. xviii. figs. 2, *a–d*.

¶ Michelin, *op. cit.* p. 118, pl. xx. figs. 1, *a–f*.

the height one half the length and not one-third; moreover, the granules on the ridges between the poriferous furrows are less numerous. In these respects the fossil agrees more closely with *C. imperialis*, a Miocene species from Crete. Michelin's figures do not show the side-view of the test, but in his description he gives dimensions which show the proportions.

The following table illustrates the relations of the Cretan and Armenian specimens of *C. imperialis* and *C. olisiponensis*:—

	C. imperialis.		*C. olisiponensis.*
	Michelin's type.	Specimen from Urmi.	Type.
Height	75 mm.	47 mm.	40 mm.
Length	175 „	92 „	127 „
Width	145 „	87 „	105 „
Ratio of height to length	1 : 2·3	1 : 1·95	1 : 3·0
„ „ width	1 : 1·9	1 : 1·85	1 : 2·6
Number of granules on ridge between interporiferous furrows	5	3–4	10

These dimensions show that the specimen is far closer to *C. imperialis* than to *C. olisiponensis*. As the elevation of the test is not illustrated in Michelin's figures, that aspect is shown on Plate 28. fig. 1. The petals in this specimen are unusually flat, and the test is very thick.

2. Clypeaster Guentheri, n. sp. (Plate 28. fig. 2.)

Diagnosis.—Test pentagonal, with well-rounded angles. The base is flat, with sharp, slightly sinuous ambitus. Upper surface flattened. Anterior slope at an angle of 45°–50°, fairly regular; posterior slope steep to a posterior foot-like projection. Length of test approximately equal to the width, and $3\frac{1}{2}$ times as great as the height. Apical disc excentric posteriorly.

Petals very tumid, broad and completely closed externally; the outer end is broad and well rounded. The petals are long, and reach about three-fourths of the distance from apical area to the ambitus. The anterior ambulacrum is longer than those of the parietal series.

Periproct large, circular, and close to the margin.

Granules of interporiferous ridges about four on each ridge.

Dimensions.

	Specimen from Urmi.	Specimen figured by Abich.	*C. turritus*, Phil.		
	mm.	mm.	mm.	mm.	mm.
Height	23	45	37	37	67
Length	82	120	55	75	119
Width	81	112	52	64	112

Affinities.—A large specimen of this species was figured by Abich as *Clypeaster turritus*, Philippi, a species which was admirably figured and described by its founder *. The specimen referred to *C. turritus* by Abich seems to me a very distinct form. In *C. turritus* the height is almost exactly half the length, whereas in Mr. Günther's specimen it is less than a third the length; in Abich's specimen it is almost a third the length. A still more important difference is in the length of the petals. In *C. turritus* the ratio of the length of the petal to the non-petaloid portion of the ambulacrum between the petal and the ambitus is as 2 : 1. In *C. Guentheri* the ratio is as 3 : 1.

C. turritus is one of the conical, pyramidal species of *Clypeaster*. *C. Guentheri*, on the contrary, is one of the flat-topped, depressed species. Its nearest ally is *C. gibbosus* (Risso) †, which differs in having a higher and longer test and fewer granules on the interporiferous ridges.

Fischer ‡ has already suggested that Abich's *C. turritus* should be included as a synonym of *C. gibbosus*. But Fischer figured as *C. gibbosus* an echinid which is distinct from Abich's *C. gibbosus*; Fischer's *C. altus* § is, however, probably the same as *C. Guentheri* and *C. turritus* of Abich.

* R. A. Philippi, "Ueber *Clypeaster altus*, *C. turritus*, und *C. scillæ*," Palæontogr. vol. i. 18—, p. 323, pl. xxxviii. figs. 1–5.

† *Scutella gibbosa*, Risso, Hist. Nat. Europe mérid. 1826, v. p. 284; Michelin, *op. cit.* p. 120, pl. xxii. figs. *a–g*, pl. xxiii. figs. 1, *a–c*.

‡ P. Fischer in Tchihatcheff, "Asie Mineure," Paleontologie, 1866–69, p. 306.

§ *Ibid.* p. 308, pl. vii. fig. 1.

Pomel * has founded a species, *C. suboblongus*, on some specimens from Corsica and Algeria, which are closely allied to *C. Guentheri*, but they appear to me to be closer to *C. gibbosus*. *C. suboblongus*, at any rate, differs from *C. Guentheri* by having a longer and more gradual posterior slope, without the separation into the steep upper part and thin basal foot. In *C. Guentheri*, moreover, the petals are proportionately longer, and the interporiferous granules less numerous, and there are fewer plates in the petaloid portions of the ambulacra (about 40 instead of about 60).

Abich included *C. altus* in his synonyms of *C. turritus*; but in his explanation of plates he quoted the specimen as *C. altus*, Lam., var. *turritus*, Philippi. That he was right in identifying *C. turritus* with *C. altus* I have urged previously †. Later on, Abich figured another specimen of *C. altus*; the specimen cannot be determined satisfactorily from the figure, but the echinid is certainly not a *Clypeaster*, and is probably a *Conoclypeus*.

3. Clypeaster Martini, *Desmoulins* ‡.

Abich, in 1882, figured an echinid from the Lower Miocene of Mamachatun which he referred to this species; the specimen is imperfect, and the ambulacra are so badly shown that the identification might have been questioned. But Mr. Günther's collection includes three specimens which must, I think, be referred to *C. Martini*, and thus support Abich's identification. Mr. Loftus's collection in the British Museum includes another specimen (E. 2446) which may be included in the same species, though the petals are more tumid than in the other specimens.

The five specimens in question are by no means identical in form. One of Mr. Günther's specimens is too fragmentary to be of service; but the dimensions of the other four specimens and of Michelin's figured specimen of *C. Martini* are given on the opposite page. The dimensions for *C. melitensis*, Mich., and *C. Michelotti*, Ag. (*fide* Michelin) are also added.

* A. Pomel, 'Paléontologie de l'Algérie: Zooph., Fasc. 2. Échinodermes,' Livr. 2, 1887, pp. 192–3, pl. B xxiii. figs. 1–6.

† J. W. Gregory, "The Maltese Fossil Echinoidea," Trans. R. Soc. Edinb. vol. xxxvi. pt. 3, 1891, p. 594.

‡ C. Desmoulins, "Études sur les Échinides," Mém. 3, Actes Soc. Linn. Bordeaux, vol. ix. 1837, p. 64; Michelin, *op. cit.* p. 134, pl. xxxv. fig. 1.

	Figured by Abich.	Mr. Günther's specimens.		Loftus Collection.	Michelin's type.	*C. melitensis.*	*C. Michelotti.*
Height	14 mm.	21 mm.	26 mm.	32 mm.	19 mm.	45 mm.	20–35 mm.
Length	100 „	? 100 „	101 „	90 „	98 „	170 „	90–145 „
Width at anterior angle	85 „	89 „	88 „	75·5 „	84 „	150 „	80–130 „
„ posterior „	83 „	77 „	—	72 „	78 „		
Ratio of length of petal to radius of the test	—	3 : 5	3 : 4·9	3 : 4·3	3 : 4·8	3 : 4	3 : 4·1
Number of granules on interporiferous ridge	—	6	8	—	5–8	10	9

The main difference between the three specimens of *C. Martini* from Guverchin Kala is in the tumidity of the ambulacra. This character is least developed in the more broken of Mr. Günther's specimens, and most pronounced in the specimen in the Loftus Collection, which presents an approach to *C. crassicostatus*, Agassiz.*

Among the specimens of *Clypeaster* from the Indian Cainozoic this species is closest to *C. faloriensis*, Dunc. & Sladen †, which has the same long open petals and depressed test; but in the Indian specimen the margin is tumid and the height of the test less.

FOSSIL CORALS.

By J. W. Gregory, D.Sc., F.G.S.

(Plate 28.)

The fossil corals in Mr. Günther's collection from Lake Urmi number 19 specimens, of which 6 came from the conglomerates at Seir, 6 or 8 miles west from the lake, and 8 came from the island of Koyun Daghi; the exact locality of the remainder is not stated. One of the specimens from Seir and one from Koyun Daghi are indeterminable. The rest may be divided among eight species, which have been previously recorded or described from Lake Urmi by Abich ‡. The corals are Miocene, and mainly Helvetian in affinities. The *Ostrea-Virleti* beds which yield *Thamnaræa polymorpha* are shown by the Mollusca, according to Mr. R. B. Newton, to be Tortonian in age.

1. Orbicella Defrancei (*Edwards & Haime*), 1849.

One of the best-preserved corals in Mr. Günther's collection is a fragment of a flat tabular corallum, about 15 mm. thick, in which the septa number three orders with rarely a rudimentary septum of the fourth order; the septa are thick near the margin, but have no paliform lobes; the columella is parietal, but strong

* Michelin, *op. cit.* p. 115, pl. xvii. figs. 1, *a–f*.

† Duncan & Sladen, "Fossil Echinoidea of Kachh and Kattywar," Pal. Indica, ser. XIV. vol. i. pt. 4, 1883, p. 50, pl. xii. fig. 15.

‡ H. Abich, 1859, "Ueber das Steinsalz und seine geologische Stellung im Russischen Armenien," Mém. Ac. Imp. Sci. St. Pétersb. ser. 6, vol. ix. pt. 1, Mém. Sci. Math.-Phys. vol. vii. pp. 89–102; and 1882, 'Geologische Forschungen in den Kaukasischen Ländern,' Abth. ii. Geologie des Armenischen Hochlandes, i. Westhälfte, pp. 270, 273, 274, 281–283.

and rod-like; the exotheca develops as horizontal layers, and is not vesicular; the costæ are long and prominent on the surface; the calices are 5–6 mm. in diameter, and are separated by exothecal bands from 2–6 mm. in width.

The coral is accordingly an *Orbicella*, and agrees very closely in structure with the corals from Urmi figured by Abich * in 1859 as *Astrea Guettardi*. That the coral is identical with that so determined by Abich I have no doubt; but his naming of the species is open to question. *Orbicella Guettardi* was founded by Defrance † on a figure by Guettard ‡; the species has been admirably refigured by von Reuss §, and described by Edwards and Haime ‖. Von Reuss's figures confirm those of Guettard in showing that the exotheca is vesicular, that the septa are four cycles in number, that at least the primary septa have paliform thickenings, and that the diameter of the calices is over 10 mm. In all these characters the Urmi specimens are different; the septa belong to 3 cycles, there are no paliform lobes, the exotheca is lamellar, and the calices are from 5–6 mm. in diameter. The Persian specimens must therefore be transferred to *O. Defrancei* (Ed. & H.) ¶, a Lower Miocene species from Dax and Northern Italy, which has been recorded from Asia Minor by Fischer **, whose figures agree with those of Abich and with Mr. Günther's specimen. Michelin †† has figured the species from Northern Italy under the name of *A. argus*, Lam., and von Reuss ‡‡ has given excellent figures of it. The specimens figured by Abich §§ as *Astrea Defrancei* are different, and one of them is here described as a new species.

* H. Abich, *op. cit.* 1859, p. 89, pl. ii. fig. 4, pl. v. fig. 5.

† Defrance, 1826, Dict. Sci. Nat. vol. xlii. p. 379.

‡ Guettard, Mém. sur différ. Parties Sci., vol. iii. 1770, pl. xlviii. figs. 2–4.

§ Von Reuss, "Pal. ält. Tertiärsch. Alpen," Denkschr. Akad. Wiss. Wien, vol. xxviii. 1869, p. 245, pl. xxiii. figs. 1, 2.

‖ Milne-Edwards & Haime, Hist. Nat. Cor. vol. ii. 1857, p. 462.

¶ Milne-Edwards & Haime, Mém. Astr. pt. 3, Ann. Sci. Nat., Zool. ser. 3, vol. xii. 1849, p. 106.

** P. Fischer in Tchihatcheff's 'L'Asie Mineure,' Paléont., 1866–1869, p. 314, pl. xvi. figs. 4–6.

†† H. Michelin, Icon. Zooph. 1842, p. 59, pl. xii. fig. 6.

‡‡ Von Reuss, "Foss. Kor. öster.-ung. Mioc.," Denk. Ak. Wiss. Wien, vol. xxxi. 1871, p. 239, pl. ix. fig. 3, pl. x. fig. 1.

§§ Abich, 1859, *op. cit.* p. 93, pl. ix. fig. 6; 1882, *op. cit.* pp. 272, 273, pl. vii. figs. 15–20.

2. Orbicella Guentheri, n. sp.

Diagnosis. Corallum massive, and growing apparently in tabular expansions.

Corallites of medium size; closely packed, and therefore appearing angular in shape, and usually hexagonal. Exotheca narrow but dense, forming a stout wall.

Septa three complete orders, and an imperfect fourth order represented. Seen from the exterior, the six primary septa are especially conspicuous.

Columella large, appearing substyliform.

Dimensions.

	From Abich's figure.	Specimen from Seir.
	mm.	mm.
Diameter of corallites	8–9	5–7
Diameter of calice	5–6	3–4
Width of wall	$1\frac{1}{2}$–2	$\frac{1}{2}$–$1\frac{1}{2}$

Affinities. This species is founded on three corals—one figured by Abich * as *Astrea Defrancei*, and the other two collected by Mr. Günther in the conglomerate of Seir, 6 to 8 miles west from Lake Urmi. The corals agree very closely, the only difference between them is the somewhat smaller diameter of the corallites in the specimens from Seir.

The coral differs from *O. Defrancei* in three important characters:—The corallites are smaller in diameter; the wall is narrower, denser, and not lamellar; the corallites are polygonal, and they are not divided by valleys or depressions between the raised calycinal margins. Hence the coral appears to me quite distinct from *O. Defrancei*. It may be distinguished from *O. vesiculosus* (Ed. & H.) † owing to the absence of the vesicular endotheca and exotheca.

In 1882 Abich figured two additional Armenian astreans as *Heliastræa Defrancei*. Of these the first variety ‡ is probably

* Abich, 1859, *op. cit.* p. 93, pl. ix. fig. 6; ? also 1882, *op. cit.*, *Heliastræa Defrancei*, var. 1, p. 273, pl. vii. fig. 20.

† M.-Edwards & Haime, Mém. Astr. pt. 3, Ann. Sci. Nat., Zool. ser. 3, vol. xii. 1849, p. 107.

‡ Abich, 1882, *op. cit.* p. 273, pl. vii. fig. 20.

a specimen of *O. Guentheri*; the transverse section looks different from that of Abich's figure (pl. ix. fig. 6 *a*) of 1859, but that figure was probably based on an altered specimen in which the true internal structure was obscured. The second variety is no doubt a worn fragment of *O. Haimei* (d'Archiac) *.

3. Orbicella Haimei (*d'Archiac*) †, 1866.

This species was founded for a specimen said to come from the Lower Tertiary of Thrace. D'Archiac's figure agrees so closely with two specimens from the Seir conglomerate, that I feel doubt as to the correctness of the Thracian horizon. The two specimens agree in all essential characters; but the smaller specimen has been rolled and worn so that the corallites are left separated by a raised wall, instead of by intercalicular depressions.

The dimensions of the type and of the specimens from the Seir conglomerate are given herewith :—

	Type.	Specimens from Seir.	
	mm.	mm.	mm.
Length of corallum	130 by 75	80 by 50	70 by 50
Thickness „	—	70	30
Diameter of corallites	9–20 (average about 15).	8–15	15

The coral figured by Abich in 1882 ‡ as *Heliastræa Defrancei* var. 2, is probably a specimen of this species.

4. Solenastræa turonensis (*Michelin*), 1847 §.

This widely distributed Helvetian coral is represented by two specimens—a large mass 130 mm. in diameter from the conglomerate at Seir, and a rolled specimen from Koyun Daghi. In reference to the latter, it should be noted that the lithological condition of the fossil is very different from that of the other specimens from that island. As usual in fossil specimens of *Solen-*

* Abich, *ibid.* p. 274, pl. vii. fig. 15.

† *Heliastræa Haimei*, d'Archiac in Tchihatcheff's 'L'Asie Mineure,' Paléont., 1866–69, p. 191, pl. xv. figs. 5, 6.

‡ Abich, 1882, *op. cit.* p. 274, pl. vii. fig. 15.

§ *Astræa turonensis*, Michelin, 1847, Icon. Zooph. p. 312, pl. lxxv. figs. 1, 2; *Solenastræa turonensis*, Edwards & Haime, 1857, Hist. Nat. Cor. vol. ii. p. 498.

astræa, the septa are seldom preserved; but they are shown in a few corallites of the Koyun Daghi example. The species occurs in Egypt*, but has not, so far as I am aware, been previously recorded from Asia Minor or Persia. Abich † quotes a *Solenastræa astroites* from Lake Urmi, and that record may have been based on *S. turonensis*. Abich did not give figures, and accepted the species for the *Sarcinula astroites* (Goldf.)‡, which, according to Milne-Edwards & Haime §, is a synonym of *Orbicella Ellisi* (Defr.). That determination is quite consistent with Goldfuss's instructive figure. Abich quoted as a second reference the *Solenastræa columnaris* (Rss.)‖, which appears quite distinct both from "*Sarcinula astroites*" and from *Solenastræa turonensis*.

5. Prionastræa irregularis (*Defrance*), 1826 ¶.

This species has been recorded from Armenia by Abich, who has figured a specimen collected between Malu and Khoi, which shows the deep steep-walled calicular fossa of this species. Mr. Günther's collection includes two specimens from Lake Urmi, exact locality not stated.

6. Phyllocœnia Archiaci, *Edwards & Haime*, 1848 **.

This species was recorded by Abich from Koyun Daghi, but his figures alone are not convincing of the specific identification. Mr. Günther has collected two other specimens from the same locality, which enable the characters to be more fully determined. The Armenian specimens differ from Milne-Edwards and Haime's diagnosis in the more solid nature of the exotheca and in the apparent absence of the numerous granulations on the costæ, which are said to be visible on worn specimens. The specimens from Koyun Daghi are extremely worn, and it may be that the

* J. W. Gregory, "Egypt. Foss. Madrep.," Geol. Mag. dec. 4, vol. v. p. 247.

† Abich, 1882, *op. cit.* p. 282.

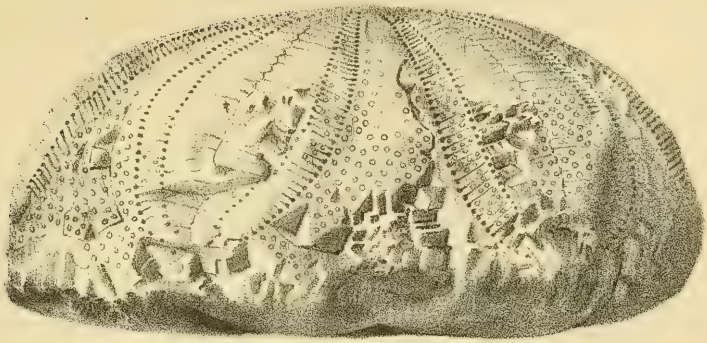
‡ Goldfuss, Petref. Germ. vol. i. p. 73, pl. xxiv. fig. 12.

§ Milne-Edwards & Haime, Hist. Nat. Cor. vol. ii. 1857, p. 467.

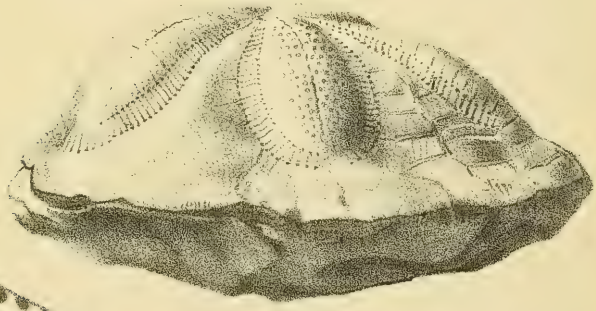
‖ Von Reuss, "Pal. ält. Tertiärsch. Alpen," pt. i. Denkschr. Ak. Wiss. Wien, vol. xxviii. 1868, p. 170, pl. xi. figs. 7–9.

¶ *Astræa irregularis*, Defrance, 1826, Dict. Sci. Nat. vol. xlii. p. 381; *Cellastrea irregularis*, de Blainville, 1830, *ibid.* vol. lx. p. 342. Figured by Michelin, 1842, Icon. Zooph. p. 61, pl. xii. fig. 9, but the figure is indefinite.

** Milne-Edwards & Haime, Mon. Astr. pt. i., Ann. Sci. Nat., Zool. ser. 3, vol. x. 1848, p. 303.



1. $\frac{1}{1}$



2. $\frac{1}{1}$

3b. $\frac{1}{1}$

3a $\frac{10}{1}$

E. Drake ad nat. lith. West, Newman imp.

FOSSIL ECHINOIDEA AND CORALS, FROM LAKE URMI.

granulations have been thus obliterated. In the compactness of the exotheca the corals approach Abich's *Astrea grandistella* *, which, owing to the absence of columella, is probably also a *Phyllocœnia*; but as the nature of the exotheca and union of the corallites is not shown by the figures, its generic position cannot be absolutely determined.

The two specimens from Koyun Daghi are flat-topped, tabular coralla, and in the larger specimen the corallites show a tendency to become elliptical or subtriangular.

There is a third specimen in Mr. Günther's collection from Koyun Daghi referable to *Phyllocœnia*; it has well raised calicular margins, as in *P. irradians*, Ed. & H. †, but the fragment is too small and worn for satisfactory determination.

7. Thamnaræa polymorpha (*Abich*) ‡, 1859. (Plate 28. fig. 3.)

This interesting coral was well figured by Abich, whose specimens came from Lake Urmi and Malischent or Maku. Their specific identity with specimens collected on Koyun Daghi by Mr. Günther is unquestionable. The horizon of the coral on this island is settled by the fact that one of them is attached to an *Ostrea* which Mr. R. B. Newton has identified as *O. Virleti*.

The generic position of the coral is a matter of some interest, as *Thamnaræa* has not previously been recorded from Miocene or even Cainozoic deposits. That the coral is not a *Porites* is shown by three characters: the absence of pali, the strongly developed, imperforate septa, and the presence of the conspicuous synapticular platforms, which are well shown in Abich's figures. On casual inspection the coral appears spongiform rather than corallian in structure.

Thamnaræa was founded by Thurmann & Etallon § in 1864, and has recently been discussed by Dr. Ogilvie ‖, who includes it in the Madreporidæ; but, with Etallon, von Zittel, and Duncan, I include it among the Microsolenidæ.

* Abich, 1859, *op. cit.* p. 92, pl. ii. fig. 3.

† This species has been recorded from the Oligocene of Erivan by Abich, 1882, *op. cit.* p. 257, pl. vii. fig. 16.

‡ *Porites polymorpha*, Abich, 1859, *op. cit.* p. 100, pl. ix. figs. 1, *a–e*.

§ "Leth. Brunt.," Neue Denk. schweiz. Ges. Naturw. vol. xx. p. 411.

‖ M. M. Ogilvie, "Kor. Stramb. Sch.," Palæontogr. Suppl. ii. pt. 7, p. 153.

8. ? Porites leiophylla, *von Reuss* *, 1847.

The collection includes a large nodular corallum 100 mm. long by 80 mm. wide and 40 mm. thick, which is a cast of a *Porites*. It agrees in characters with Abich's † description of the coral from the islands of Lake Urmi referred to *P. leiophylla*. It differs from von Reuss' type of that species by the greater size of the corallites. This feature may only be the result of the greater size of the corallum. The coral is only a cast, so that its determination is difficult, and it may be provisionally left in the species to which Abich assigned it. The corallites in the present specimen vary from 7–10 mm. in diameter.

EXPLANATION OF PLATE 28.

Fig. 1. *Clypeaster imperialis*, Mich., side view, nat. size.
2. *Clypeaster Guentheri*, n. sp., side view, nat. size.
3. Transverse and radial sections of *Thamnaræa polymorpha*, × 10 diam. Tortonian, Koyun Daghi, Lake Urmi.
a. Transverse section across a series of corallites, × 10 diam.
b. Section across part of a transverse section of a branch, showing the corallites cut longitudinally, with the synapticular platforms.

MARINE TERTIARY [MIOCENE] MOLLUSCA.

By R. Bullen Newton, F.G.S., of the British Museum (Natural History).

(Plates 29 & 30.)

Introduction.

This communication deals with a number of Marine Tertiary Mollusca obtained from Lake Urmi and its vicinity by Mr. R. T. Günther, who has generously presented the specimens to the Geological Department of the British Museum.

The specimens are mostly casts and frequently much water-worn, yet of considerable interest since they serve to increase the number of species already recorded from this area.

* Von Reuss, "Foss. Polyp. Wien. Tertiärb.," Haid. Naturw. Abh. vol. ii. pt. 1, p. 28, pl. v. fig. 4.

† Abich, 1859, *op. cit.* p. 101.

One Lamellibranch, which appears to differ from every known form, is here described (p. 447) as a new species under the name of *Meretrix persiensis*.

Speaking generally, the collection consists of Miocene species, although a few of its members assume a facies indicative of the Aquitanian division of the Tertiary rocks, which by some authors (*e. g.* Gümbel and Fuchs) is regarded as Lower Miocene, and by Lapparent and others as Upper Oligocene.

From palæontological evidence it would appear that the Tertiary rocks of Lake Urmi form part of an extensive series of deposits which is traceable through Asia Minor, Southern Europe (Greece, Vienna Basin, Italy, and Spain), Egypt (Siwa Oasis, Pyramids, Geneffe), Northern Africa, and Madeira.

The following remarks on the localities represented in the collection may be of interest.

The majority of the specimens were obtained from the beach and cliffs of the Island of Koyun Daghi, which, according to Abich, has an elevation of 5258 feet above sea-level, and in section is seen to be composed entirely of Miocene rocks resting on a Palæozoic base—(*a*) the highest bed contains *Alectryonia Virleti*; (*b*) beds of marble appearance with Corals; (*c*) concretionary limestones with *Turritella Archimedis, T. turris, T. gradata*, &c.; (*d*) Palæozoic rocks.

The following species from this locality are represented in Mr. Günther's Collection :—

Alectryonia Virleti, Ostrea pseudodigitalina, Ostrea lamellosa, Pecten suburmiensis, Pecten allied to *Burdigalensis, Pecten* (*Flabellipecten*) sp. indet., *Chlamys* (*Æquipecten*) *Malvinæ* affin., *Chlamys* sp. indet., *Cardita* sp. indet., *Strombus* like *Bonelli, Conus* sp. indet., *Turritella Archimedis, Turritella gradata* var., *Turritella rotifera* affin., *Latirus crispus*.

In considering the zone or zones of the Miocene system to which these forms should be referred, it may be observed that the presence of *Alectryonia Virleti, Latirus crispus, Ostrea lamellosa*, &c., would suggest a later age than that represented by *Turritella Archimedis, T. gradata* var., *Pecten* allied to *Burdigalensis*, &c. It is therefore quite possible that these older species are of Helvetian age, whereas the others are probably Tortonian, or even later, as they occur also in Pliocene deposits. The specimens from Koyun Daghi are in a cream-coloured marly

calcareous rock; those found on the beach being very much rounded and thickly impregnated with salt.

Another of Mr. Günther's localities is that of Guverchin Kala (see sections made by Mr. Loftus in 1855), from which the following species have been identified in his collection:—

Pecten convexocostatus, *Pecten suburmiensis*, *Venus Aglauræ*, *Meretrix persiensis*, *Meretrix* like *incrassata*, *Pyrula cingulata*, *Cassis* sp. indet.

This assemblage of forms is suggestive of two horizons—one, represented by *Pecten convexocostatus* and *P. suburmiensis*, which is probably Helvetian; the other, on account of such species as *Venus Aglauræ*, *Meretrix Persiensis*, *M.* like *incrassata*, *Pyrula cingulata*, *Cassis* sp. indet., is most likely of Burdigalian age or even older, as the shells referred to exhibit the Aquitanian facies before mentioned, besides being lithologically distinct. The Pectiniform species are in a light-coloured limestone; whereas the supposed older specimens are preserved as casts of reddish-brown colour, and came probably from near the base of the "Loftus Section" (? about no. 7 bed), having been collected and given to Mr. Günther by the Rev. C. Labaree, of the American Mission Station.

Some further specimens have been obtained from other localities close by, which are referred to in the body of this paper and do not call for any special reference now, except that, judging from their characters, they indicate a Lower Miocene age, and belong either to the Helvetian or Burdigalian stages of that period.

A summary of previous work on the invertebrate palæontology of Lake Urmi and neighbourhood may now be given.

In 1855 W. K. Loftus * published his geological researches on the Turko-Persian frontier, in which is described the "White Limestone" promontory (regarded by Loftus as of Upper Nummulitic age) bearing the ancient fortress of Guverchin Kala (=Castle Rock), situated at the northern extremity of Lake Urmi. A detailed section of this point, where the rocks rise perpendicularly to a height of more than 400 feet, is given thus (taken from p. 305 of the paper by Loftus):—

"The following is a careful descending section of the Castle

* Loftus, W. K.—"On the Geology of Portions of the Turko-Persian Frontier and of the Districts adjoining," Quart. Journ. Geol. Soc. 1855, vol. xi. pp. 247–344, & Geological Map.

Rock. The beds are all conformable to each other, and dip at an angle of 7° towards the E.S.E., which dip is of course due to the igneous rocks of the Wurgowiz spur on the north.

"1. Compact, hard, crystalline, white limestone, becoming concretionary in passing downwards, afterwards marly.	
2. Light-blue marl, with hard flesh-coloured flints and nodules, and irregular fragments of limestone. It contains abundant Corals *in situ* and in layers, below which are numerous specimens of *Clypeaster*, *Echinolampas*, *Pecten*, *Serpula*, and casts of various Univalve and Bivalve shells.	
3. Compact mass of highly crystalline coralline nodules in hard marls.	
The thickness of the above three beds is about..	250 feet
4. Fine reddish gravel, or coarse sand-conglomerate, much hardened, and filled with fragments of fossils	18 „
5. Friable yellow sandstone, very finely grained, with fragmentary fossils	15 „
This bed passes into	
6. Hard and compact, grey, marly limestone, filled with Corals and casts of shells	6 „
7. Hard reddish marl, abounding in shells	21 „
8. Brownish-yellow, friable sandstones, with several thin layers of gravel and conglomerate, of variously-sized rounded pebbles	100 „
Total thickness of Section	410 ft."

Dr. H. Abich * issued his first paper on the palæontology of this region in 1858, accompanying it with an excellent geologically coloured map taking in the whole of the islands on Lake Urmi, and recognizing them as belonging to the "Miocène inférieur." His determinations of the fossils inclined him to consider that they should be referred to the "Molasse Moyen"

* Abich, H.—"Tremblement de Terre observé à Tébriz en septembre 1856, Notices physiques et géographiques de M. Khanykof sur l'Azerbeidjan," Bull. Classe Physico-Math. Ac. Imp. Sci. Saint-Petérsbourg, 1858, vol. xvi. pp. 340–341, pl. iii. (=Geological Map: coloured).

or "Falunien" (Orbigny) age of the Mediterranean Basin, which he stated was identical with the "Calcaire Moëllon" of Marcel de Serres and very similar in characters to the Leithakalk of Austrian geologists.

This author also called attention to the great extent of the Miocene deposits, which he stated could be traced from Marocco through Greece to Lake Urmi.

The following fossils, collected by M. Khanykof from the islands on Lake Urmi, were listed without descriptions or figures as follows:—

Actinozoa (Corals):

Porites dendroidea, n. sp.
Astræa Guettardi, Defr.
—— *Ellisiana*, Defr.
—— *Defrancei*, M.-Edw.
Phyllocœnia Archiaci?, M.-Edw.

Echinodermata:

Clypeaster altus, Lam.
—— *crassicostatus* affin., Ag.
Echinolampas complanatus, n. sp.

Bryozoa:

Cellepora gracilis, Münst.
Ceriopora palmata, Orb.
—— *anomala*, n. sp.
Polytrema spongiosa, Orb.
Diastopora gemmifera, n. sp.
Membranipora fenestrata, Eichw.

Lamellibranchiata:

Ostrea Virleti, Desh.
—— *excavata*, Desh.
—— *lamellosa*, Lam.
Pecten benedictus, Lam.
—— *flabelliformis*, Brocchi.
—— *simplex*, Mich.
Spondylus bifrons, Goldf. (Münst.).

Gasteropoda:

Haliotis Philberti, Serres.

Much more systematic work on the fossils of this locality was

carried out by Abich* in the same year, when he figured and described the following species as having been obtained from the "Bryozoen und Foraminiferen-Kalkstein" division of his "Supra-Nummulitenkalk" series, at Urmi and neighbourhood.

FORAMINIFERA:

Polystomella quaterpunctata, n. sp.

ACTINOZOA (Corals):

Astræa Guettardi, Defr.
—— *Ellisiana*, Defr.
—— *Defrancii*, M.-Edw.
—— *grandistella*, n. sp.
Phyllocœnia d'Archiaci, M.-Edw.
Porites polymorpha, n. sp.
—— *leiophylla*, Reuss.

ECHINODERMATA:

Clypeaster altus, var. *turritus*, Phil.
—— *diversicostatus*, n. sp.
Echinolampas complanatus, n. sp.

BRYOZOA:

Ceriopora palmata, Orb.
Polytrema spongiosa, Phil.
Cellepora gracilis, Münst.
Diastopora gemmifera, n. sp.
Membranipora fenestrata, Eichw.
Ceriopora anomala, n. sp.

LAMELLIBRANCHIATA:

Pecten planicostatus, n. sp., *P. convexocostatus*, n. sp.,
P. benedictus, Lam., *P. maximus*, Linn.,
P. burdigalensis, Lam.,
P. flabelliformis, Brocchi, *P. simplex*, Michelotti,
P. varius, Linn.
Spondylus bifrons, Goldfuss.
Ostrea Virleti, Desh., *O. excavata*, Desh.,
O. lamellosa, Lamarck.

GASTEROPODA:

Haliotis Philberti, Serres.

* ABICH, H.—"Ueber das Steinsalz und seine geologische Stellung im Russischen Armenien," Mém. Ac. Imp. Sci. St. Petérsbourg, 1858, ser. 6, vol. vii. pp. 61–150, pls. 1–10. Although read December 14, 1856, and issued as an author's copy in 1857, this paper was not published until 1858.

During 1873 Dr. W. T. Blanford * published his views regarding the Salt swamps and lakes of Persia, including the lake of Urmi; and in 1876 the same author †, in his 'Eastern Persia,' gives a special chapter on the geology of Persia generally with an exhaustive *résumé* of all previous work on the subject.

A distinct advance was made by Dr. Abich ‡ in his great work of 1882, which includes a geological profile section of the islands (p. 275) on Lake Urmi, representing them to be composed of Miocene rocks resting on a Palæozoic base, having the *Ostrea Virleti*-beds at the top of the series. The elevation of the principal island, that of Koyun Daghi, is stated to be 5258 feet above sea-level.

In this work the following species of Miocene age are described and (mostly) figured as having been collected on the "Urmia Plateau":—

Actinozoa (Corals):

Phyllangia grandis, Reuss.
—— *alveolaris*, Catullo.
Cyathomorpha gregaria, Catullo.
—— *conglobata*, Reuss.
Astrangia princeps, Reuss (allied).
Solenastræa astroites, Goldfuss.
Heliastræa Guettardi, Defr.
Porites polymorpha, Abich.

Echinodermata:

Clypeaster turritus, Phil.
—— *Scillæ*, Desm.
Echinolampas complanatus, Abich.

Lamellibranchiata:

Venus Aglauræ, Brongn.
Pecten suburmiensis, n. sp.
—— *convexocostatus*, Abich.
—— *lychnulus*, Fontannes.

* Blanford, W. T.—"On the Nature and probable Origin of the Superficial Deposits in the Valleys and Deserts of Central Persia," Quart. Journ. Geol. Soc. 1873, vol. xxix. pp. 493–503.

† Blanford, W. T.—'Eastern Persia, an Account of the Journeys of the Persian Boundary Commission, 1870–1872': 1876, vol. ii. p. 439–506.

‡ Abich, H.—'Geologie des Armenischen Hochlandes.' 1882.

Pecten Tournali, Serres.
—— *subopercularis*, n. sp.
—— *Malvinæ* (allied), Dubois.

Gasteropoda:

Turritella Archimedis, Brongn.
—— *turris*, Orbigny.
—— *rotifera*, Desh. (allied to).
—— *gradata*, Menke, var.
—— *margarita*, n. sp.

These species are additional to those cited in Abich's work of 1858, which were mostly obtained from the islands on Lake Urmi; with the following alterations in nomenclature: *Pecten maximus* to be *P. Tournali*, Serres; *P. simplex* to be *P. Holgeri*, Geinitz.

Dr. Rodler * in 1888 reported the occurrence of Jurassic fossils at the following localities off the eastern side of Lake Urmi:—Aktahu-dere, Tazeh-kend, Ilditsch, Guschaisch, and the Karangu Valley. The genus *Harpoceras*, which was found in the Karangu Valley, he regarded as indicative of Middle or Upper Lias; whereas *Perisphinctes* from the other localities might belong to either the *P. polyplocus*-zone of Kimeridge age or the *P. curvicosta*-zone, which is Callovian. Rodler's researches also includes a chapter on the origin of Lake Urmi.

This was followed in 1890 by a memoir from Dr. K. Anton Weithofer † on the Jura and Cretaceous rocks of North-western Persia, in which the following Mollusca are described and partially figured, as having been collected to the east of Lake Urmi (Guschaisch and Tazeh-kend) in the neighbourhood of Maragha:—

Upper Lias:

Harpoceras cf. *radians*, Reinecke.
—— cf. *kurrianum*, Oppel.
Belemnites sp. indet.
Pecten cf. *disciformis*, Schübler.
Pleuromya sp. indet.

* Rodler, Dr. Alfred.—"Einige Bemerkungen zur Geologie Nordpersiens," Sitzunsgb. K. Akad. Wiss. (Wien), 1888, vol. xcvii. pt. i. pp. 203–212.

† Weithofer, Dr. K. Ant.—"Ueber Jura und Kreide aus dem nordwestlichen Persien," Sitzungsb. K. Akad. Wiss. (Wien), 1890, vol. xcviii. pt. i. pp. 756–773, pls. i. & ii.

Upper Oolite (Lower Kimeridge):

Perisphinctes Lothari, Oppel.
—— cf. *polyplocus*, Reinecke.
Belemnites persicus, n. sp.
Goniomya Rodleri, n. sp.

Cretaceous (Neocomian):

Olcostephanus tetrameres, n. sp.
—— *Straussi*, n. sp.
—— new form indet.
—— (*Hoplites*?) cf. *narbonensis*, Pictet.

Dr. Georg von dem Borne* in 1891 contributed a valuable monograph on the fossils from the Eastern side of Lake Urmi (Guschaisch, Chanajan, Aktahu-dere, Scurgan and Tazeh-kend), which were described and figured from the following horizons:—

(1) Kelloway (*anceps*-zone).
(2) Kelloway ? (*macrocephalus*-zone).
(3) Upper Lias (*Jurensis*-zone).

His identifications may be thus tabulated:—

Cephalopoda:

Belemnites cf. *calloviensis*, Oppel.
—— *Persicus*, Weithofer.
—— sp. (=*B. acuarius*-group).
Ludwigia nodosa, Quenst., sp.
—— *krakoviensis*, Neumayr, sp.
—— *gigas*, Quenst., sp.
—— *lunula*, Zieten, sp.
—— cf. *punctata*, Stahl, sp.
—— spp. indet.
Macrocephalites sp. indet.
Stephanoceras stenostoma, n. sp.
Perisphinctes curvicosta, Oppel.
—— *paneaticus*, Nötling.
—— *cyrus*, n. sp.
—— *tetrameres*, Weithofer, sp.
—— *poculum*, Leckenby, sp.
—— *Xerxes*, n. sp.
—— spp. indet.
—— *balinensis*, Neumayr.

* Borne, Georg von dem.—'Der Jura am Ostufer des Urmiasees.' [Dissertation Thesis.] Halle, 1891; with several plates of fossils.

Reineckia Straussi, Weithofer, sp.
—— sp.
Harpoceras Atropatenes, n. sp.
—— *kapautense*, n. sp.
—— *mediæ*, n. sp.

GASTEROPODA:

Spinigera, n. sp. indet.
Pleurotomaria sp.

LAMELLIBRANCHIATA:

Pecten cf. *disciformis*, Schübler.
Mytilus Matianus, n. sp.
Trigonia Roxanæ, n. sp.
—— sp.
Pleuromya urmiensis, n. sp.
—— like *arata*, Brauns.
Gresslya sp.

ANNELIDA:

Serpula sp.

DESCRIPTION OF THE SPECIES.

The synonymy here employed is not intended to be exhaustive; only the principal works are enumerated, and these must be referred to for more complete details. For the sake of brevity, the following memoirs, quoted in the synonymy, are mentioned under the name of the "Serial" in which they originally appeared:—

ABICH, H.—Ueber das Steinsalz und seine geologische Stellung im Russischen Armenien: *Mém. Ac. Imp. Sci. St. Pétersbourg*, 1858, ser. 6, vol. vii.

BASTEROT, B. de.—Description Géologique du Bassin Tertiaire du Sud-ouest de la France (Mollusques Fossiles): *Mém. Soc. Hist. Nat. Paris*, 1825, vol. ii. pt. 1.

FUCHS, T.—Ueber die von Dr. Tietze aus Persien mitgebrachten Tertiärvesteinerungen: *Denkschr. K. Akad. Wiss.* (*Wien*), vol. xli. pt. 2.

FUCHS, T.—Beiträge zur Kenntniss der Miocänfauna Aegyptens und der Libyschen Wüste: *Palæontographica*, 1883, vol. xxx.

HÖRNES, M.—Die fossilen Mollusken der Tertiär-Beckens von Wien (Univalven und Bivalven); *Abhandl. k.-k. Geol. Reichs.*, 1856–1870, vols. iii. & iv.

LAMELLIBRANCHIATA.

OSTREA PSEUDODIGITALINA, *Fuchs*.

Ostrea pseudodigitalina, Fuchs, Denkschr. K. Akad. Wiss. 1879, vol. xli. pt. 2, pl. 3. figs. 4–6, p. 107.

This species is of elongate shape, pointed at the summit and rounded basally; it is related to *O. digitata* of Eichwald, but appears to differ in possessing costæ of considerably less digitiform character. The upper valve is flat and ornamented with prominent growth-lines. Other closely allied species are *O. Rholfsi* of Fuchs, from the Siokuh mountains in Persia, and *O. digitalina* var. *Rholfsi* of the same author, from the Miocene beds of Egypt. The specimens are fragmentary; representing four lower valves and three upper valves.

Fuchs first recorded this species from the Miocene (=Schio-Schichten) of the Siokuh mountains in Persia.

Locality. In a grey marly matrix from the beach of the island of Koyun Daghi.

Formation. Miocene (Helvetian ?).

OSTREA LAMELLOSA, *Brocchi*.

Ostrea lamellosa, Brocchi, Conch. Foss. Subapennina, 1814, vol. ii. p. 564; Abich, Mém. Ac. Imp. Sci. St. Pétersbourg, 1858, ser. 6, vol. vii. pl. 5. fig. 3, p. 126 (68); Hörnes, Abhandl. k.-k. Geol. Reichs. 1870, vol. iv. pl. 71. figs. 1–4, pl. 72. figs. 1, 2, p. 444.

A single fragmentary upper valve is all that represents this shell; and it seems to agree remarkably well with Abich's interpretation of the species as illustrated in his "Steinsalz" monograph. It is slightly convex near the summit, and the external surface exhibits the regular concentric and lamellose striations characteristic of this species. It has been previously recorded from Italy (Brocchi); Urmi (Abich); Vienna Basin (Hörnes); Asia Minor (P. Fischer in Tchihatcheff); Greece (Gaudry), &c.

Locality. In a grey marly rock from the beach of the island of Koyun Daghi.

Formation. Miocene (Tortonian or Helvetian).

The species is distributed through the Miocene and Pliocene periods, and still survives in the Mediterranean.

ALECTRYONIA VIRLETI, *Deshayes*.

Ostrea Virleti, O. excavata, O. pseudoedulis, Deshayes, Expéd. Sci. Morée, 1833, vol. iii. (Zool.), pl. 21. figs. 1–6, pp. 122–124.

Ostrea Virleti, O. excavata, Abich, Mém. Ac. Imp. Sci. St. Pétersbourg, 1858, ser. 6, vol. vii. pl. 2. figs. 1, 2; pl. 3. figs. 1, 2; pl. 5. figs. 1, 2; pp. 124 (66), 125 (67).

Ostrea Virleti, Fuchs, Denkschr. K. Akad. Wiss. 1879, vol. xli. pt. 2. pl. 4, p. 106; and Palæontographica, 1883, vol. xxx. pl. 9. (4), pl. 10. (5), p. 43 (25).

Ostrea (*Alectryonia*) *Virleti,* R. B. Newton, Geol. Mag. 1899, p. 205.

This is a most abundant species in Persia, occupying the topmost bed of the Miocene section at Koyun Daghi island, as given by Dr. Abich in his 1882 work. It is a form of somewhat variable shape, though exhibiting external plications on both valves, which places it in the genus *Alectryonia.* These plications may sometimes be more or less obsolete according to age and wear; the valves are mostly depressed, though the *excavata* form has a very convex lower valve. Mr. Günther's specimens are fairly typical of the species and correspond with Dr. Abich's figures of the same.

The species has been previously recorded from the Miocene rocks of Morea (Deshayes); Siokuh Mountains, Persia (Fuchs); Egypt (Fuchs); Azores &c. (Mayer-Eymar); Crete (Raulin); Cyprus (Gaudry); Malta (Wright); and a variety of this species is recorded from the Pliocene deposits of Altavilla, Italy, by Gregorio (Boll. Soc. Mal. Italia, 1884, vol. x.).

Localities. Several specimens were obtained from the beach of the island of Koyun Daghi; and one fragmentary valve came from the cliff-section of the same island.

Formation. Miocene, probably about the age of the Leithakalk, which is Tortonian.

Pecten Beudanti, *Basterot.* (Plate 29. fig. 2.)

Pecten Beudanti, Basterot, Mém. Soc. Hist. Nat. Paris, 1825, vol. ii. part 1, pl. 5. fig. 1, p. 74; Hörnes, Abhandl. k.-k. Geol. Reichs. 1867, vol. iv. pl. 59. figs. 1–3, p. 399; T. Fuchs, Denkschr. K. Akad. Wiss. 1879, vol. xli. pt. 2. p. 105; R. B. Newton, Geol. Mag. 1899, p. 207.

A large convex lower valve, contained in this collection, appears to be referable to *P. Beudanti.* The fine, striated sculpture of the surface, however, through erosion by water or weathering, so conspicuous a feature of this species, is almost obliterated, although it can be obscurely traced in places. In every other respect it agrees with Hörnes' interpretation of Basterot's shell. It is very transverse (dimensions in millimetres = height 87, length 110, depth 35), and bears about 16 wide plano-convex

costæ separated by grooves of rather less width. Sacco has recorded this species from the Helvetian Beds of Piedmont (Boll. Soc. Geol. Italiana, 1889, vol. viii. p. 331).

The species has been previously known from Bordeaux (Basterot); Portugal (J. de C. Sowerby); Constantine (Coquand); Sardinia (Meneghini); Piedmont (Sacco); Persia (Fuchs); Egypt (Newton).

Locality. In a matrix of compact, cream-coloured foraminiferal limestone; from the neighbourhood of Urmi.

Formation. Miocene (Helvetian).

Pecten convexo-costatus, *Abich.*

Pecten convexo-costatus, Abich, Mém. Ac. Imp. Sci. St. Pétersbourg, 1858, vol. vii. pl. 1. figs. 4*b*, 4*c*, p. 188; Geol. Armenischen Hochlandes, 1882, pl. 1. figs. 6, 6 *a*, pl. 8. fig. 2, p. 276; Fuchs, Palæontographica, 1883, vol. xxx. pl. 21 (xv.). figs. 1, 2, p. 40 (58).

Two lower valves of this species are attached to a piece of yellowish-white limestone. They are much weathered so that the fine concentric striæ are almost obsolete, but the characteristic convex and narrow costæ numbering from 20–22 are prominently shown. This is a fairly distinct species, and not to be confused with Eichwald's *P. aduncus* of 1830, from Poland, which has wider, fewer, and more depressed ribs, and which Hörnes regarded as synonymous with *P. convexo-costatus*, uniting both under the older name.

Abich's original specimens were obtained from the neighbourhood of Urmi; the species is also recorded from Egypt by Fuchs.

Locality. Guverchin Kala, north end of Lake Urmi.

Formation. Miocene (Helvetian).

Pecten suburmiensis, *Abich.*

Pecten suburmiensis, Abich, Geol. Armenischen Hochlandes, 1882, pl. 8. figs. 1–8*a*, p. 276.

This species is represented by a number of lower valves, which although rather fragmentary show the characteristic wide, curved, and depressed costæ crossed by obscurely fine striations; the umbonal region is rounded and incurved. The original specimens were described by Abich as from the Urmi Plateau.

Localities. Two examples are in a drab-coloured limestone, and were found at Guverchin Kala, northern end of Lake Urmi; two others are in a greyer rock localised as from the same place;

the remaining specimens are considerably water-worn, having been obtained from the beach at the island of Koyun Daghi.

Formation. Miocene (Helvetian).

PECTEN (AMUSSIOPECTEN) like BURDIGALENSIS, *Lamarck.*

Pecten Burdigalensis, Lamarck, Annales du Muséum, 1809, vol. viii. p. 355; Goldfuss, Petrefacta Germaniæ, 1833, vol. ii. pl. 96. fig. 9, pp. 66, 80; Abich, Mém. Ac. Imp. Sci. St. Pétersbourg, 1858, vol. vii. p. 120 (62); Hörnes, Abhandl. k.-k. Geol. Reichs. 1867, vol. iv. pl. 65, p. 418.

Amussiopecten Burdigalensis, Sacco, Moll. Terz. Piemonte, &c., 1897, pt. 24, pl. 15. figs. 1–7, p. 53.

Pecten (Amussiopecten) Burdigalensis, R. B. Newton, Geol. Mag. 1899, p. 209.

This form is represented by a very much worn specimen, with rather imperfect margins. It shows wide and slightly raised costæ; and the surface is covered with numerous obsolete concentric striations. Dr. Fuchs' Persian shell from the Siokuh mountain, *P. placenta*, appears to be closely related to it (Denkschr. K. Akad. Wiss. 1879, vol. xli. pl. 2, figs. 1, 2, p. 104).

The true *Burdigalensis* is a well-known Miocene species, being found in both the Helvetian and Burdigalian divisions of that period, and it forms the type of Sacco's sub-genus *Amussiopecten*.

Locality. From the beach of the island of Koyun Daghi.

Formation. Miocene (Helvetian ?).

PECTEN (OOPECTEN) ROTUNDATUS, *Lamarck.* (Plate 29. fig. 1.)

Pecten rotundatus, Lamarck, Hist. Nat. Anim. sans Vert. 1819, vol. vi. pt. 1, p. 179; T. Fuchs, Denkschr. K. Akad. Wiss. 1879, vol. xli. pt. 2, pl. 2. figs. 1, 2, p. 104; Fontannes, Hist. Periode Tert. Rhône, 1880, vol. vi. pl. 1, fig. 1, p. 161.

Oopecten rotundatus, Sacco, Moll. Terz. Piemonte, &c., 1897, pt. 24, pl. 15. figs. 14, 15, p. 54.

Original specific description:—"*P. testa suborbiculari, utrinque convexa; radiis* 14 *ad* 16 *distinctis, convexis, versus limbum planulatis.*

"Largeur 75 millimètres. Il est moins bombé que le *P. multiradiatus* et que le *P. rugosus*." (Lamarck.)

A small block of a light brown calcareous sandstone obtained from a conglomerate contains remains of this species; the best preserved valve having a height of 60 millimetres and a length of rather more than 70 millim.

It agrees with the original diagnosis as given above, and corresponds with Dr. T. Fuchs' later interpretation of the same,

this author having identified it among some Persian fossils obtained from the Siokuh mountains. Lamarck's original specimen is localised as from Vence, near Grasse in France, which Fuchs considers as belonging to the "Horner Schichten" division of the Miocene; it has been well figured by Fontannes, who tabulates it as of Lower Helvetian age. This species forms the type of Sacco's sub-genus *Oopecten*, and its range in Italy, according to the same author, is from the top of the Aquitanian into the Helvetian.

Locality. Seir Hill, 6–8 miles west of Urmi.

Formation. Miocene (Helvetian or Burdigalian?).

Pecten (Flabellipecten) sp. indet.

This determination refers to a fragmentary pectinoid shell exhibiting a very slightly convex lower valve, with about 16 rounded radial costæ separated by very wide interspaces, some obscure concentric striations on the ribs and grooves being discernible in places.

It is probably an example of *P. Besseri*, Andrejowski, from the Polish Miocene (Bull. Soc. Nat. Moscou, 1830, vol. ii. pl. 6. fig. 1, p. 103), but the intercostal grooves are mostly filled with matrix, and the specimen is otherwise so poorly preserved that a more definite identification is not possible.

There is no doubt as to its belonging to Sacco's sub-genus *Flabellipecten*, of which the type is *P. flabelliformis*, Brocchi, sp.

Locality. From the beach of the island of Koyun Daghi.

Formation. Miocene (Helvetian).

Chlamys (Æquipecten) Malvinæ, *Dubois de Montpéreu* affin., *H. Abich.* (Plate 29. fig. 4.)

Pecten Malvinæ, affin., Abich, Geol. Armenischen Hochlandes, 1882, pl. 8. fig. 7, p. 278.

The collection contains five fragments of a Pectinoid shell which appear to be the equivalent of that form regarded by Dr. Abich as allied to *P. Malvinæ* of Dubois de Montpereux (Conch. Foss. Wolhyni-Podolien, 1831, pl. 8. figs. 2, 3, p. 71). The most complete example has from 18–20 narrow, rounded costæ, extremely fine at the umbone, but afterwards widening, and separated by deep grooves; the lateral ribs having a tendency to curve. The entire surface is covered by fine, equidistant, transverse, imbricating or squamose striations. The shell is probably a oun form, as there is no indication of the ribs dichotomizing.

The true *P. Malvinæ* possesses a greater number of ribs, which radiate in straight lines from the umbone without any apparent curvature on the lateral areas. The present Persian specimens are probably more closely allied to *P. opercularis* of Linnæus, from which they are most difficult to separate after comparison with the Pliocene representatives of this species contained in the "Searles Wood" collection in the British Museum. This particular form of *Pecten* belongs to P. Fischer's sub-genus *Æquipecten*, founded in 1886 on *P. opercularis*, Linnæus, sp.

Locality. Beach specimens from the island of Koyun Daghi; Dr. Abich's specimens were obtained from the "Urmia Plateau."

Formation. Miocene (Helvetian).

Chlamys sp. indet.

Two specimens have been determined as above. One consists of an impression of a valve in a small block of limestone. It possesses numerous radial, almost contiguous costæ, which are divided up into twos and threes such as are typical of *P. gloria-maris* of Dubois from the Polish Miocene, but without the echinations on the ribs distinguishing the European form. It is of ovately oblong shape, and from the character of the costæ clearly belongs to the genus *Chlamys*. The other specimen has similar costal details, and was obtained from the island of Koyun Daghi.

Locality. In a cream-coloured limestone with foraminifera and other small organisms, found on the road from Sujbulak to the Plain of Solduz; and from the cliff of the island of Koyun Daghi.

Formation. Miocene (Helvetian).

Chlamys sp. indet. (Plate 29. fig. 3.)

This specimen has about 16 rounded costæ divided by deep and wide grooves which are feebly marked by extremely fine oblique striations; the costæ show obscure indications of dividing besides being ornamented with numerous slightly elevated scabræ or spines. There is only one example of this form in the collection; it has both valves attached and is considerably worn so that the sculpture is difficult to define; its dimensions in millimetres=height 42, length 38, and depth 18. The specimen is probably related either to *P. gloria-maris*, Dubois, *P. opercularis*, Linnæus, sp., or to *P. pusio*, Linnæus, all of which are

included under the genus *Chlamys* of Boltem, 1798 (type *Ostrea varia*, Linnæus), by Sacco and other authorities.

Locality. Neighbourhood of Urmi.

Formation. Miocene (? Helvetian).

Cardium sp. indet. (Plate 29. fig. 5.)

This is a sandstone-cast of a valve belonging to the genus *Cardium*, measuring the same both in its height and length, viz. 19 millimetres, and in depth 8 mm. Where preserved, the vertical striations on the surface are numerous and very close together; in the ventral area obscure lines of growth can be traced.

Without more material it is difficult to speak of the nearest ally of a specimen of this description. It slightly resembles a Lower Tertiary form from Asia Minor figured by d'Archiac in Tchihatcheff's 'Asie Mineure,' 1866–69, pl. xi. figs. 6, 7, p. 162, under the name of *Cardium* indet., which however is longer than high and scarcely so convex as the Persian shell.

Locality. Found in the same brown calcareous sandstone accompanying *P. rotundatus* at Seir, 6 to 8 miles west of Urmi.

Formation. Miocene (Helvetian or Burdigalian).

Venus Aglauræ, *Brongniart.* (Plate 30. figs. 1, 2.)

Corbis? Aglauræ, Brongniart, Mém. Séd. sup. Calc.-Trapp. Vicentin, 1823, pl. 5. fig. 5, p. 80.

Venus Aglauræ, Hörnes, Abhandl. k.-k. Geol. Reichs. 1861, vol. iv. pl. 14. figs. 1–4, p. 122; P. Fischer, "Faune Tert. Moyen," in Tchihatcheff's 'Asie Mineure,' 1866–69, p. 290; Abich, Geol. Armenischen Hochlandes, 1882, pl. 4. fig. 5, p. 278.

Original diagnosis.—*Transversim fere elliptica, ventricosa, cancellata, lamellis transversis crebris ad latera plicato-crispis, serratis.* (Brongniart.)

This well-known species is represented by a single specimen with closed valves somewhat imperfect and worn. The original sculpture of the shell can be fairly seen in places, exhibiting the close characteristic concentric lamellose structure crossed by fine longitudinal striations. The specimen is of typical shape, being transversely elliptical, having a short rounded anterior region and an obliquely curved postero-dorsal margin; the lunule and escutcheon are a good deal obscured by matrix.

Dimensions (in millimetres). Height=about 60; length=68; depth =38.

Brongniart's original example of this species was obtained from the Oligocene (Tongrian) rocks of Castel Gomberto of North Italy (this correlation being according to Lapparent, 'Traité de Géologie,' 1893, p. 1292). Under the name of *V. granosa* it has been recorded from the Miocene (Gaj series) deposits of Cutch, India (J. de C. Sowerby); it occurs in the Vienna Basin at Gauderndorf &c. (Hörnes), in the Lower Miocene or Burdigalian stage; "Urmia Plateau" (Abich); Asia Minor (P. Fischer); Saucats; Turin, &c.

Locality. Guverjin Kala, north end of Lake Urmi. Specimen having a reddish-brown colour externally; the matrix within appearing to be a grey, marly, calcareous rock. (Collected by the Rev. C. Labaree.)

Formation. Miocene (Burdigalian or Aquitanian).

MERETRIX PERSIENSIS, n. sp. (Plate 30. figs. 3–5.)

Shell transversely ovate, inequilateral, anterior end truncate and short, posterior extremity rounded and produced; valves convex, dorsal margin rounded and long, surface ornamented with concentric sulcations; beaks very anterior, incurved, having beneath a small, fairly deep, cordiform lunule; escutcheon lanceolate.

Dimensions (in millimetres). Height=28; length=45; depth =29.

This species is represented by one specimen having both its valves united. It appears to differ from other forms of this genus in its transverse shape, the very anterior position of the umbones (which come beyond the shell-margins below), and the very convex rounded valves, which slope obliquely to the posterior and ventral margins.

The specimen is quite free from external matrix, its lithological aspect being similar to that observed in the forms of *Venus Aglaurœ* and *Meretrix* like *incrassata*.

Locality. Guverchin Kala. (Collected by the Rev. C. Labaree.)

Formation. Miocene (Burdigalian or Aquitanian).

MERETRIX allied to INCRASSATA, *J. Sowerby*. (Plate 30. figs. 6 & 7.)

Venus incrassata, J. Sowerby, Mineral Conchology, 1817, vol. ii. pl. 155. figs. 1, 2.

Cytherea incrassata, Deshayes, Desc. Coq. Foss. Paris, 1825, vol. i.

pl. 22. figs. 1-3, p. 136; Abich, Geol. Armenischen Hochlandes, 1882, pl. 2. fig. 8, p. 289.

Meretrix incrassata, R. B. Newton, Syst. List British Oligocene and Eocene Mollusca, 1891, p. 64.

A single specimen, consisting of a cast showing both valves, appears to have the form and thickness of *Meretrix incrassata*, as figured by Deshayes from the Paris Basin Oligocene; and, in addition, it is very similar to Abich's figure of this species, which depicts a specimen obtained from the Upper Eocene of Achalzik, in the northern part of the Armenian highlands. Our cast also shows obscure indications of a deep pallial sinus on the left valve.

Its dimensions are:—Height=35 millimetres; length=29; depth=23.

Locality. Guverchin Kala; of the same colour and aspect lithologically as observed in the *Venus Aglauræ* and *Meretrix Persiensis*. (Collected by the Rev. C. Labaree.)

Formation. Miocene (Burdigalian or Aquitanian).

Cardita sp. indet. (Plate 29. figs. 6, 7.)

This determination refers to a single specimen having both valves attached. It is inequilateral, somewhat depressed, and possesses about 20 radial, rather arched costæ, which are ornamented with a bead-like, squamulose structure, the prominences of which have been eroded by aqueous action. The anterior margin is short and rounded, whilst posteriorly it is oblique and produced; lunule small and cordate.

The specimen is in bad preservation, with the umbonal surfaces fractured. It appears to represent a new species, but without more material the present reference will suffice, although it may be said to bear a curious resemblance to the figure of *Cardita mutabilis* of d'Archiac & Haime ('Descr. Anim. Foss. Nummulitique de l'Inde,' 1854, vol. ii. pl. 21. figs. 3-6, p. 256), from the Eocene of Subathoo, North-west India.

Dimensions (in millimetres). Height=16; length=20; depth =10.

Locality. Beach of the island of Koyun Daghi.

Formation. Miocene (Helvetian).

Gasteropoda.

Strombus like Bonelli, *Brongniart*.

This specimen consists of a fragmentary water-worn cast which appears to be referable to this species. Only the two latest

whorls are present, the spire being absent. In the upper part of the last whorl there are undoubted indications of the thick tubercles which ornament that region in this species.

S. Bonelli was originally described by Brongniart from the Miocene (Helvetian) beds of Turin (Mém. Terr. Séd. Calc.-Trapp. Vicentin, 1823, pl. 6. fig. 6, sp. 74).

Locality. In a grey marly rock from the beach of the island of Koyun Daghi.

Formation. Miocene (Helvetian).

Conus sp. indet.

Two casts of this genus are present in the collection, but they are much broken, water-worn examples, and therefore not determinable.

Locality. In a grey marly rock from the beach of the island of Koyun Daghi.

Formation. Miocene (Helvetian).

Pyrula cingulata (*Bronn MS.*), *Hörnes.* (Plate 30. figs. 8, 9.)

Pyrula clathrata, Lamarck, Hist. Nat. Anim. sans Vert. 1822, vol. vii. p. 141.

Pyrula reticulata, Hörnes, Abhandl. k.-k. Geol. Reichs. 1853, vol. iii. pl. 28. figs. 1–3, p. 268, *non* Lamarck, 1822.

Pyrula cingulata, Hörnes, Abhandl. k.-k. Geol. Reichs. 1856, vol. iii. p. 676.

Represented by a brown-coloured natural cast exhibiting the shape and sculpture of this species. It has a long oval aperture, an acute and outwardly-curved labrum, a moderately excavated columella, and a very short convex spire. The large body-whorl is ornamented with broad and rather distant transverse bands, these being crossed obscurely by finer lines. The anterior canal is absent, most probably through fracture though the end is now rounded from wear. The broad spiral bands seem to separate this species from *P. condita*, Brongniart.

Dimensions (in millimetres). Length=50; diameter=34.

This species, under the name of *P. clathrata*, Lamarck, was first known from the Miocene of the Touraine district of France, although mistaken by that author for a Paris Basin form. It has been recorded also from Italy (Bronn); Poland (Eichwald); Rhône Basin (Matheron); Portugal (G. B. Sowerby); Vienna Basin (Hörnes), &c.

Locality. Guverchin Kala. (Collected by the Rev. C. Labaree.)

Formation. Miocene (Burdigalian or Aquitanian).

Cassis sp. indet. (Plate 30. figs. 10, 11.)

This specimen is an imperfect cast with a general resemblance to *C. subharpæformis*, d'Archiac & Haime (Descr. Anim. Foss. Numm. l'Inde, 1854, vol. ii. pl. 31. fig. 6, p. 317), from the Eocene rocks of India; but differing from that form in being much shorter and broader, in the *non*-bifurcate character of the vertical ribs, and the presence of some obscure concentric markings on the principal whorl. The aperture is narrowly elliptical and oblique; spire only slightly elevated.

Dimensions (in millimetres). Length=27; diameter=27.

Locality. Guverchin Kala. Of similar lithological appearance to the specimen of *Pyrula cingulata*. (Collected by the Rev. C. Labaree.)

Formation. Miocene (Burdigalian or Aquitanian).

Latirus crispus, *Borson*. (Plate 29. fig. 8.)

Fusus crispus, Borson, Mem. R. Accad. Sci. Torino, 1821, vol. xxvi. p. 317; Deshayes, Appendix to Lyell's 'Principles of Geology,' 1833, pl. 1. fig. 8, p. 30; Michelotti, Desc. Foss. Mioc. l'Italie Sept., 1847, pl. 9. figs. 17, 18, p. 272; Hörnes, Abhandl. k.-k. Geol. Reichs. 1853, vol. iii. pl. 32. fig. 3, p. 291.

Original diagnosis.—*Testa costata transversim sulcata; plicis longitudinalibus fornicatis; labio intus sulcato.* (Borson.)

A somewhat water-worn example is all that represents this species. It shows the characteristic longitudinal, elevated and rounded costulations, of which there are about eight on the principal whorl, separated by deep corresponding sulcations; the transverse sculpture consisting of numerous regular striations. The anterior canal is broken and the spire is incomplete; otherwise it preserves the fusoid and elongate shape of this form.

Dimensions (in millimetres). Length=27; diameter=15.

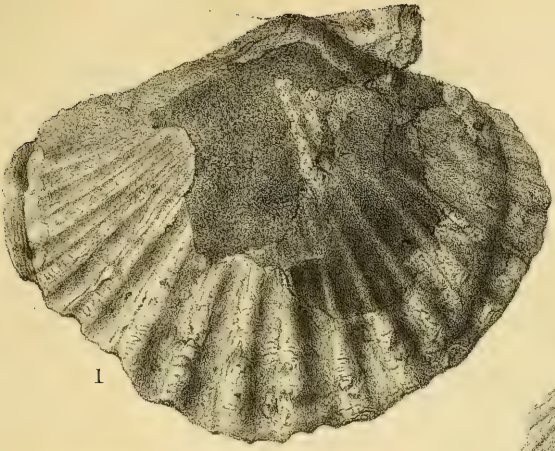
Borson's original example is localised as Piedmont, and belongs to the Tortonian stage of the Miocene, Hörnes' specimen from the Vienna Basin (Möllersdorf) being of similar horizon.

Locality. From the beach of Koyun Daghi island.

Formation. Miocene (Tortonian) The specimen has a reddish tinge similar to what is present in some of the examples of *Alectryonia Virleti*, and probably came from the same bed.

Turritella Archimedis, *Brongniart*. (Plate 29. fig. 11.)

Turritella Archimedis, Brongniart, Mém. Terr. Séd. sup. Calc.-Trapp. Vicentin, 1823, pl. 2. fig. 8, p. 55; Hörnes, Abhandl. k.-k. Geol. Reichs.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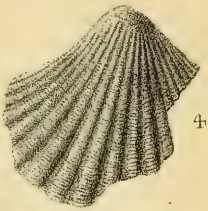
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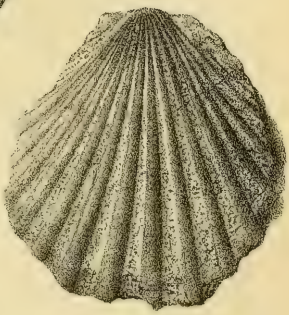
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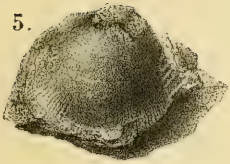
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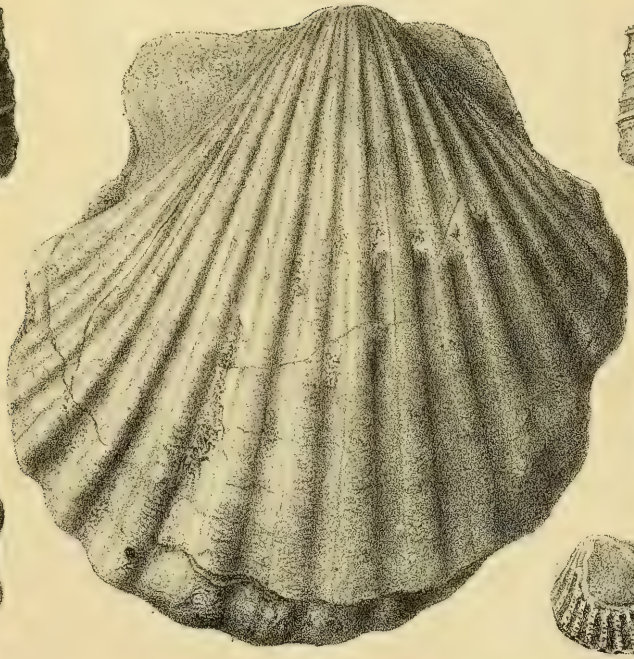
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MIOCENE SHELLS FROM LAKE URMI.


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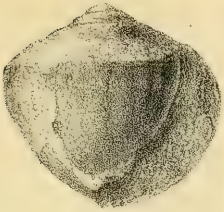
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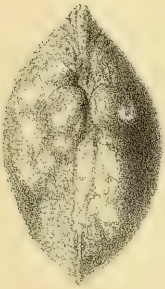
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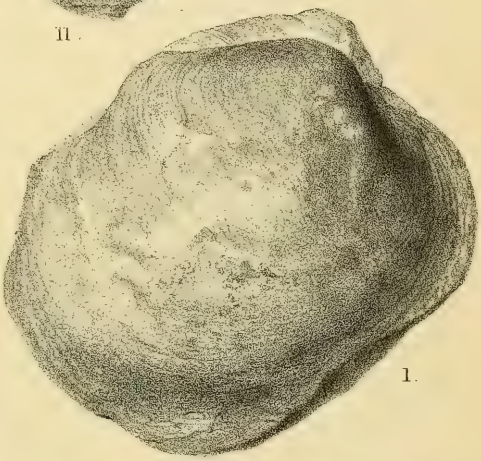
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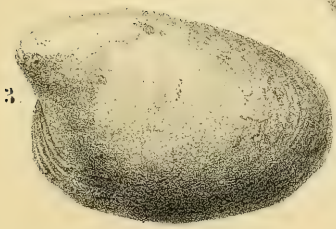
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MIOCENE SHELLS FROM LAKE URMI.

1855, vol. iii. pl. 43. figs. 13, 14, p. 424; Abich, Geol. Armenischen Hochlandes, 1882, pl. 8. fig. 14, p. 279.

This species is represented by a fragment exhibiting three whorls of the upper part of the spire, with depressed, spirally-striated surfaces and margined by prominent bicarinations.

The species occurs in Northern Italy (Brongniart); Vienna Basin (Hörnes); Egypt (Fuchs); "Urmia Plateau," north-western Persia (Abich), &c.

Locality. Koyun Daghi (beach specimen).

Formation. Miocene (Helvetian).

Turritella gradata, *Hörnes.* Var., *Abich.* (Plate 29. fig. 9.)

Turritella gradata, var., Abich, Geol. Armenischen Hochlandes, 1882, pl. 8. fig. 12, p. 280.

This consists of a water-worn fragment showing three whorls with depressed surfaces, the spiral sculpture being nearly obsolete, but having a prominent elevated keel at the base of each. Abich regarded his shell as a variety of Hörnes' *T. gradata* from the Vienna Miocene (Abhandl. k.-k. Geol. Reichs. 1855, vol. iii. pl. 43. fig. 3, p. 420), with which it seems to be closely related; his specimen was from the "Urmia Plateau."

Locality. Beach of the island of Koyun Daghi.

Formation. Miocene (Helvetian).

Turritella rotifrea, *Deshayes*, affin. *Abich.* (Plate 29. fig. 10.)

Turritella rotifera affin., Abich, Geol. Armenischen Hochlandes, 1882, pl. 8. fig. 11, p. 279.

This is a fragmentary specimen which undoubtedly belongs to the form determined by Abich as above. On account of the turreted whorls, their spiral sculpture and the equidistant prominent keels, Abich regarded this form as related to *T. rotifera* of Deshayes (Desc. Coq. Foss. Env. Paris, 1832, vol. ii. pl. 40. figs. 20, 21, p. 275), from the Paris Basin Eocene. Abich's specimen was found on the "Urmia Plateau."

Locality. From the beach of the island of Koyun Daghi.

Formation. Miocene (Helvetian),

EXPLANATION OF THE PLATES.

Plate 29.

Fig. 1. *Pecten* (*Oopecten*) *rotundatus.* Seir Hill.
2. *Pecten Beudanti.* Neighbourhood of Urmi.
3. *Chlamys* sp. indet. Neighbourhood of Urmi.

Fig. 4. *Chlamys* (*Æquipecten*) *Malvinæ* affin. Koyun Daghi.
5. *Cardium* sp. indet. Seir Hill.
6, 7. *Cardita* sp. indet. Koyun Daghi.
8. *Latirus crispus*. Koyun Daghi.
9. *Turritella gradata*, var. Koyun Daghi.
10. *Turritella rotifera* affin. Koyun Daghi.
11. *Turritella Archimedis*. Koyun Daghi.

PLATE 30.

Figs. 1, 2. *Venus Aglaurœ*. (Fig. 2=sculptur emagnified.) Guverchin Kala.
3, 4, 5. *Meretrix persiensis*, n. sp. Guverchin Kala.
6, 7. *Meretrix* allied to *incrassata*. Guverchin Kala.
8, 9. *Pyrula cingulata*. Guverchin Kala.
10, 11. *Cassis* sp. Guverchin Kala.

The figures on both Plates are drawn natural size, with the exception of fig. 2 on Plate 30.

NOTE ON A PALÆOZOIC LIMESTONE.

By R. BULLEN NEWTON, F.G.S., of the British Museum (Natural History).

AMONG Mr. R. T. Günther's geological specimens from North-western Persia is a fragment of dark slate-coloured limestone, highly crystalline, and intersected with numerous calcite veins, which was obtained from the island of Shazalan on Lake Urmi.

A microscopical examination of this rock proves that its structure is largely made up of foraminiferal remains which, with the kind assistance of Mr. Frederick Chapman, have been determined as *Endothyra Bowmanni*, Phillips, *Valvulina bulloides*, Brady, and *Nodosaria radicula*, Linnæus.

Generically, the most interesting of these forms is *Endothyra*, being essentially Carboniferous, the other genera having a far wider range in geological time.

The nearest habitat to Shazalan which has hitherto yielded *E. Bowmanni* appears to be Sloboda, in the province of Toula, European Russia, reported some years ago by V. von Möller *.

So far as can be ascertained, there is only one species of Palæozoic foraminifera yet recorded from this region, viz.,

* MÖLLER, V. v.—"Die spiral-gewundenen Foraminiferen des Russischen Kohlenkalks," Mém. Ac. Imp. Sci. St. Pétersbourg, 1878, ser. 7, vol. xxv. no. 9, p. 96, pl. iv. fig. 3, & pl. xii. fig. 2.

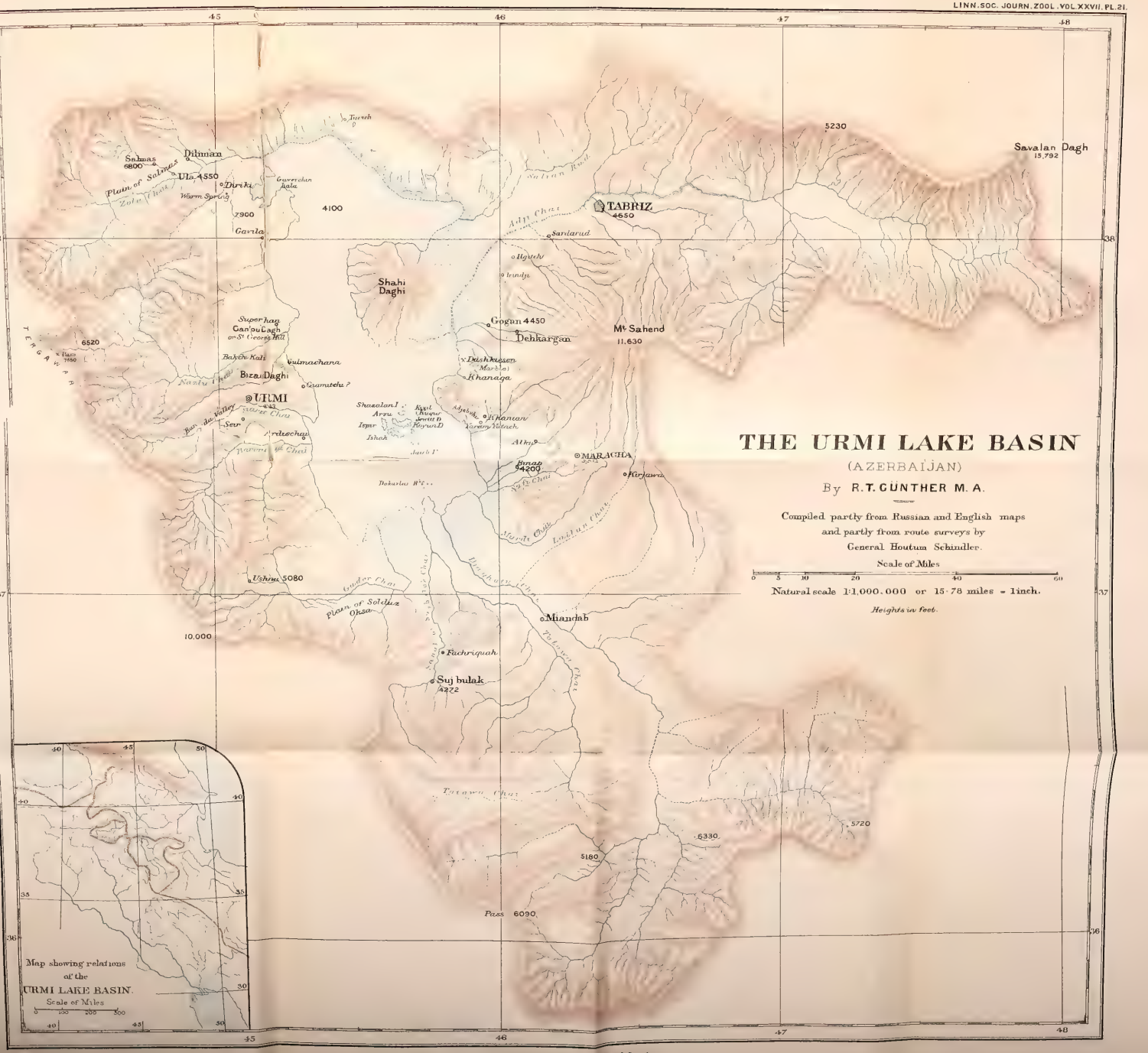
Fusulina sphærica, described and figured as a new form by Abich * in 1859 from the Bergkalk (= Carboniferous) formation of the Armenian and Persian plateaux, which shows resemblances to *Fusulina cylindrica* of Fischer, a characteristic species of European Russia.

In reference to the distribution of the older rocks in this area, attention may be called to the geological plan of the islands on Lake Urmi published by Abich † in 1882, which is of considerable value. By this we can trace the extension of these ancient deposits through Koyun Daghi and Isbir to the western shores of Lake Urmi, where in each case they form the fundamental structure on which repose the various beds of the Miocene system. Mr. Günther states, in some manuscript notes on this area, that a similar limestone as that occurring at Shazalan is to be seen at the northern end of Koyun Daghi, and possibly also on the neighbouring island of Arzu.

There appear to be no references in literature to the geology of this small island of Shazalan ; so that the example of limestone brought home from that place by Mr. Günther is of great interest, not only in adding to the list of Palæozoic Foraminifera from this neighbourhood and in establishing as Carboniferous the age of the rock in which they occur, but in extending farther northwards the distribution of this Palæozoic formation, so important an addition to the geological history of Lake Urmi.

* Abich, H.—"Vergleichende geol. Grundzüge der Kaukasusischen, Armenischen und Nordpersischen Gebirge," Mém. Ac. Imp. Sci. St. Pétersbourg, 1859, vol. vii. pl. 3. fig. 13, p. 439.

† 'Geologie des Armenischen Hochlandes,' 1882, p. 275.



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